INTERIOR VIEW OF A GRAND STAIRCASE, AND SPACIOUS ELEGANTLY FITTED HALL.—*Frontispiece.*

STAIR-BUILDING

IN ITS VARIOUS FORMS;

AND

THE NEW ONE-PLANE METHOD

OF

HAND-RAILING

AS APPLIED TO

DRAWING FACE-MOULDS,

UNFOLDING THE CENTRE LINE OF WREATHS,

AND

GIVING LENGTHS OF BALUSTERS

UNDER ALL WREATHS.

NUMEROUS DESIGNS AND PLANS OF STAIRS, NEWELS AND BALUSTERS

FOR THE USE OF

ARCHITECTS,

Stair-Builders and Carpenters.

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PREFACE.

THIS book presents for the first time—as applied to hand-railing—*the one-plane method* of drawing face-moulds, a method in which only one plane of projection is required; the simplicity, rapidity and convenience of which in practice make it superior to all others. By the one-plane process of drawing a face-mould, a centre line of wreath may also be unfolded and fixed in its relation to the elevation of tread and rise; thus determining the length of each baluster on the curved plan and gaining a knowledge and control of the wreath's exact position not before attainable.

It is intended to make this book a complete work on stair-building and hand-railing, giving a large selection of plans and designs of staircases, newels and balusters, and numerous examples of construction. The paper solids here introduced as an objective means of elementary and practical instruction in the principles and geometrical methods of hand-railing are unequalled for the purpose, as the construction of these solids with the drawings on their surfaces show all the positions and connections required in each case, and thereby enable any fairly intelligent person to understand and grasp the subject. The professional architect will find valuable suggestions in design and construction; also important considerations in planning stairs.

The experienced stair-builder will learn that this one-plane method of drawing all face-moulds—and also the manner of finding the angles with which to square wreath-pieces—is simple, uniform and rapid; and no matter how skilful a stair-builder he may be, he will find that, in the extent and completeness of detail with which the subject is treated, it will prove a valuable work of reference. The expert rail-worker will learn of the geometrical law controlling the top and bottom curves of every wreath-piece, showing that a face-mould is not only a means of shaping the sides of a wreath-piece on the plane of the plank, but that it carries with it a central geometrical curve (a helical line) that must be observed in shaping the top and bottom surfaces of the wreath. To prove this in a practical way it is only necessary to call attention to the fact that in the case of round hand-rail over any curved plan, its sides hang vertically over the plan, while its top and bottom form proper curves giving its own easings perfectly suited to the requirements in all cases; and when it is considered that a moulded rail over the same plan would be subject to the same centre and tangents, with the same joints, then the absolute control of the curves forming the top and the bottom of a wreath by this central geometrical curve-line becomes self-evident. In connection with the above statements examine for instance PLATE 48, as giving one example among many of the correctness and practical value of unfolding the centre line of a wreath.

The student or apprentice will find that the elementary study of hand-railing in the practical and novel way here presented is easily acquired; he will also see that the detail instruction given in stair-building from a stepladder to expensive and difficult staircases is presented in a manner to be clearly understood and quickly learned. That the drawings and descriptive page should be opposite I regard as of no slight importance in a work of this character; those who have experienced the weary task of turning from reference pages to plates located at another portion of the book will appreciate the value of this arrangement. The comprehensive system of hand-railing here given covers every practical requirement, as follows: 1st. By the use of tangents controlling the inclination of the plane of the plank and the butt joints; 2d. By the one-plane method of drawing all face-moulds, simply applying to this purpose a level line common to both planes; 3d. By the further use of this last-mentioned level line, in unfolding the centre line of wreath;—all of which are based upon the demonstrable laws of geometry, and point to a conclusion in the science of hand-railing as plain as that in the decimal system of numbers, which, based upon the ever-truthful laws of that branch of mathematics, is simple in its methods and perfect in its results.

Finally, it is my belief that this work is carried to an extent far beyond any publication that has preceded it; practically and scientifically covering the whole field of stair-building and hand-railing, making a complete digest of the subject.

The interesting interiors on FRONTISPIECE and PLATES 68 and 69 were kindly furnished to the author by the well-known architect Mr. W. H. Hume, 2 West Fourteenth Street, New York City. The reader will find that, in addition to being an embellishment to this work, their careful examination will well repay his study.

JAS. H. MONCKTON.

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At the starting of a first flight of stairs the front-string is frequently curved out, the curve extending from one to five treads.

MANAGEMENT OF STRINGS AND HAND-RAILS OF CURVE-OUTS.

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STAIRS.

PRIMITIVE man had little use for stairs; living in a hole dug in the ground, or a hut built of the branches and leaves of trees, or a log cabin, the utmost of his wants were doubtless supplied with a rude ladder.

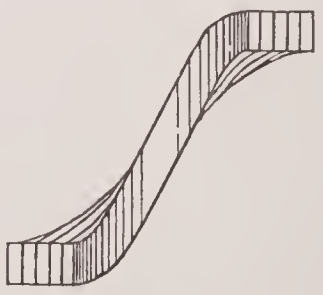
"We know little of the staircases of the Greeks and Romans, and it is remarkable that Vitruvius* makes no mention of a staircase as an important part of an edifice; indeed, his silence seems to lead to the conclusion that the staircases of antiquity were not constructed with the luxury and magnificence to be seen in more recent buildings. The best-preserved ancient staircases are those constructed in the thickness of the walls of the *pronaos*—vestibules—of temples for ascending to the roofs. According to Pausanias† similar staircases existed in the temple of the Olympian Jupiter at Elis. They were generally winding and spiral. Sometimes, as in the Pantheon at Rome, instead of being circular on the plan they are triangular. Very few vestiges of staircases are to be seen in the ruins of Pompeii, from which it may be inferred that what there were must have been of wood, and moreover that few of the houses were more than one story in height. Where they exist, as in the building at the above place called the country-house, and some others, they are narrow and inconvenient, with rises sometimes a foot in height. . . . In modern architecture the magnificence of the staircase was but tardily developed. The manners, too, and the customs of domestic life for a length of time rendered unnecessary more than a staircase of very ordinary description."‡

In England, all staircases preceding the latter part of the reign of Charles the Second —previous to 1660—were either stairs winding round a post, or the strings were framed into square newels without balusters, but close-boarded, sometimes plastered between the rail and steps. FIG. 1 is an example built about 1557 of the close-boarding, pierced as the style began, and introducing afterwards a variety of designs. Later the flat-moulded baluster was introduced, as shown by FIGS. 2, 3 and 4, and the carved balustrade, shown at FIG. 5. As the turning-lathe—a new invention of that time—came into use, turned balusters and newels were adopted, an example of which is given at FIG. 6.

At FIG. 7 is given an example of an ancient English tower staircase from Naworth Castle, Cumberland, England.

In other parts of Europe the state of the art in all probability had not progressed beyond the examples here given. With the advancement of the arts and the enormous increase of wealth many costly and magnificent staircases are now built in private dwellings of the people of Europe and America. Of public buildings, a staircase in "Goldsmiths' Hall," London, England, is said to have cost $150,000. At Washington, D. C., in the new hall of the House of Representatives, is a costly staircase built of stone with a highly artistic bronze balustrade. There are many elaborate and expensive staircases in the capitals of Europe that are important features of their public buildings. Iron and stone stairs are built on similar principles to those of wooden ones, the difference being in the treatment and changes required by the materials.

When the first fashion of continued hand-rail called for the skill of the workman, the method adopted was that of bending and gluing together a number of thin wood veneers about a convex cylinder built for the purpose. The width of these veneers equaled the thickness of the rail, and the thickness of the veneers altogether made up the width of the rail, as shown by the accompanying sketch. The solid wreath of hand-rail formed in this way, after being allowed to dry,—which a writer observes "took three weeks,"—was removed from the cylinder and carved into the shape of rail required. As late as the year 1826 instructions in the above method—although the author protested against it—were given in a book published in England by M. A. Nicholson, entitled "The Carpenter and Joiner's Companion."



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* Vitruvius, Marcus Polii, a Roman architect, 15 B.C. † Pausanias, an ancient Greek writer, 170 A.D.
‡ Gwilt's *Encyc. of Architecture.*

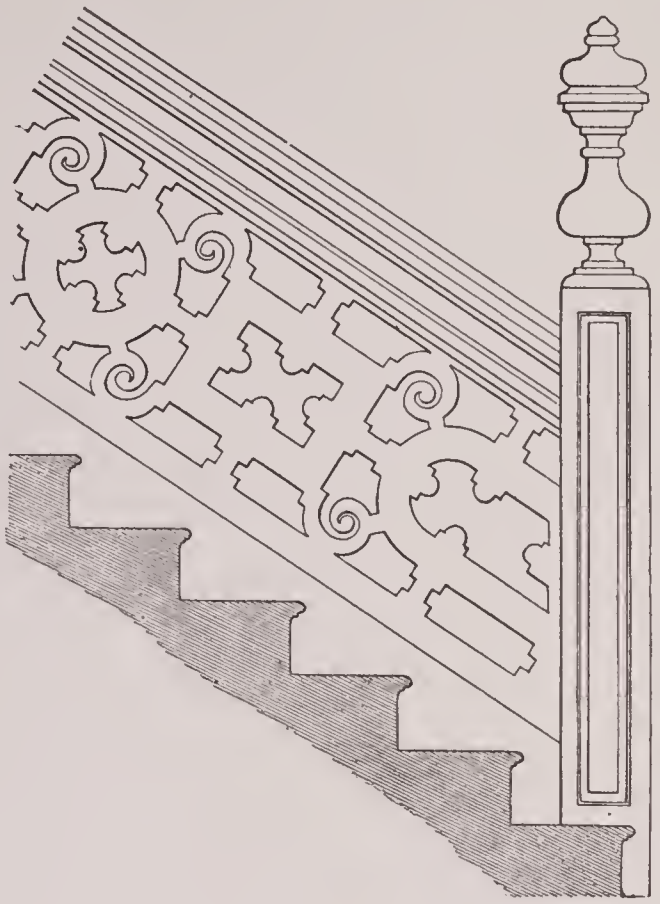
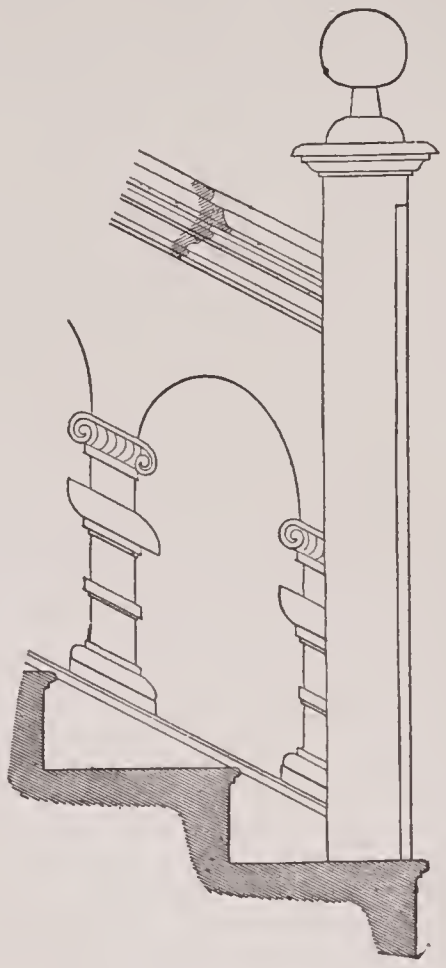


FIG. 1.



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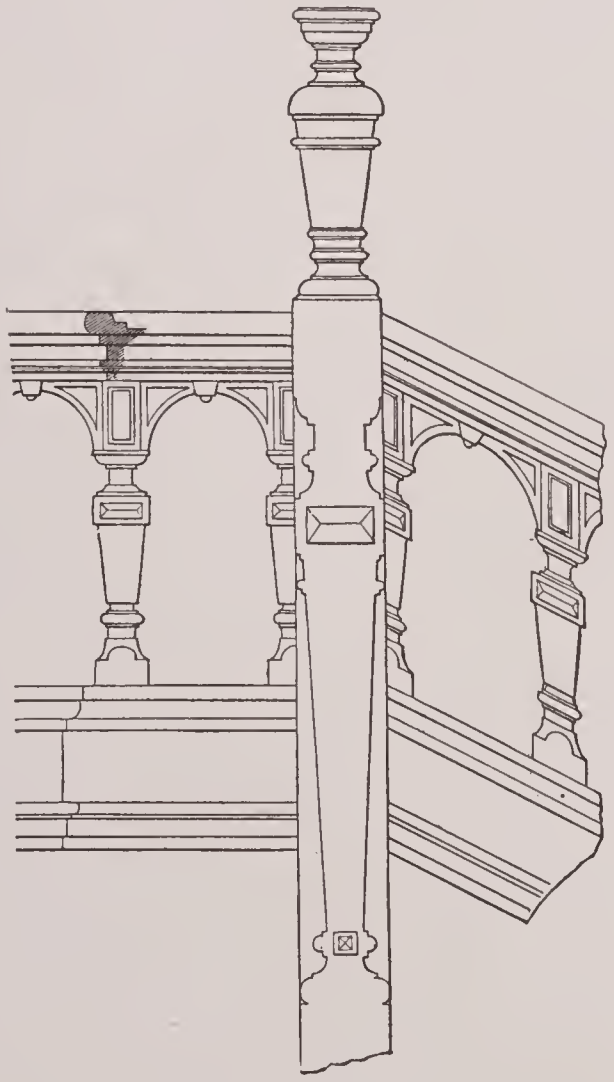

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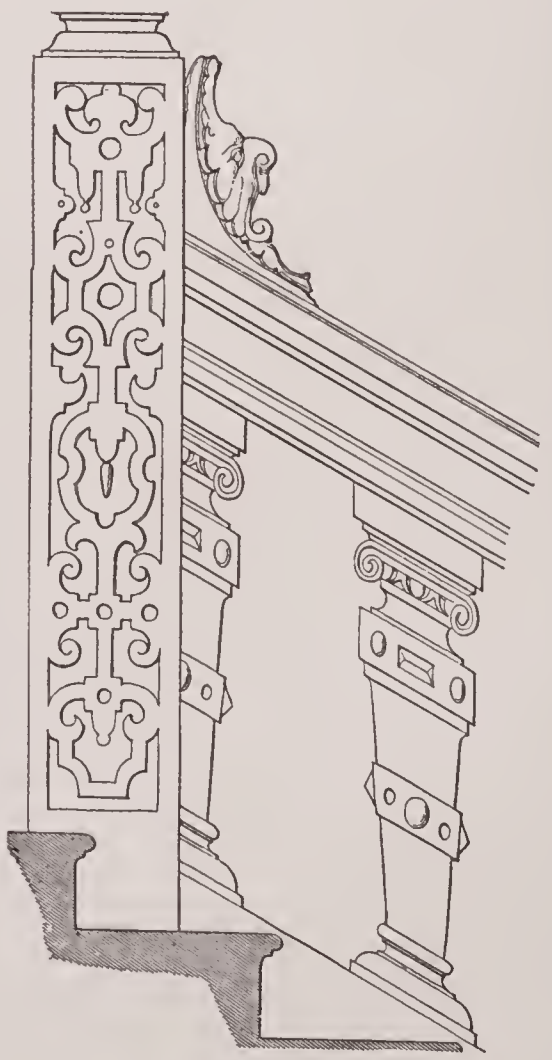


FIG. 4.

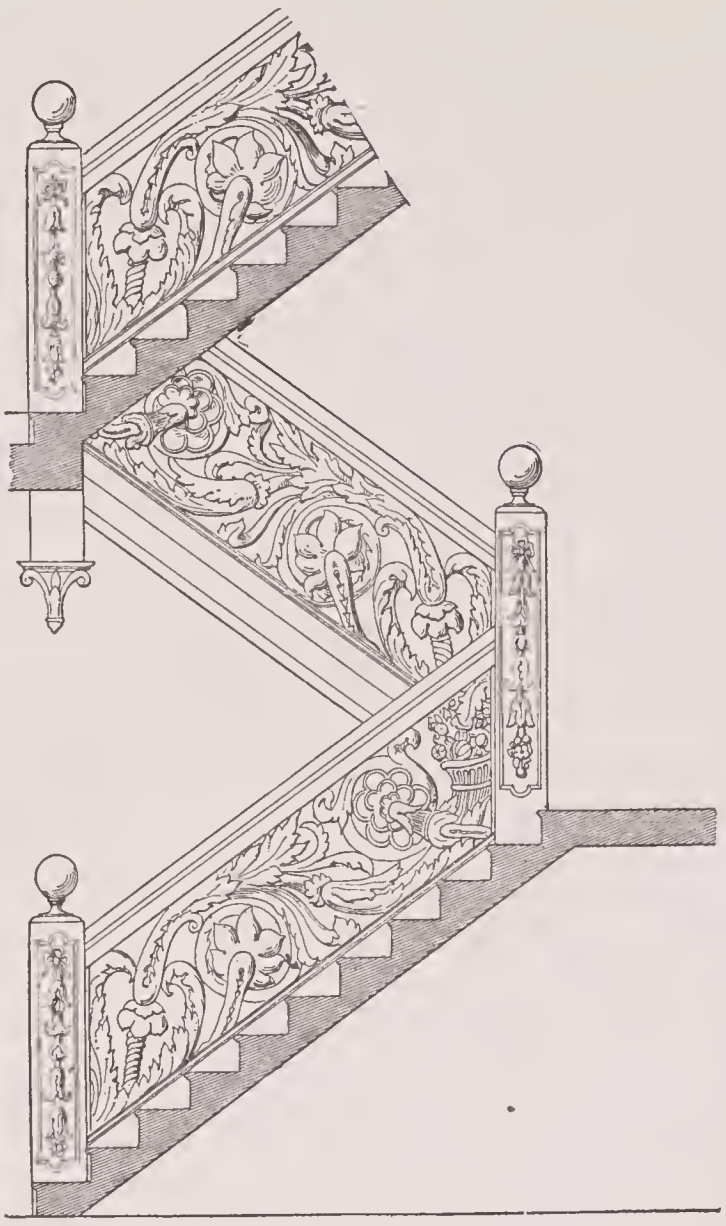


FIG. 5.

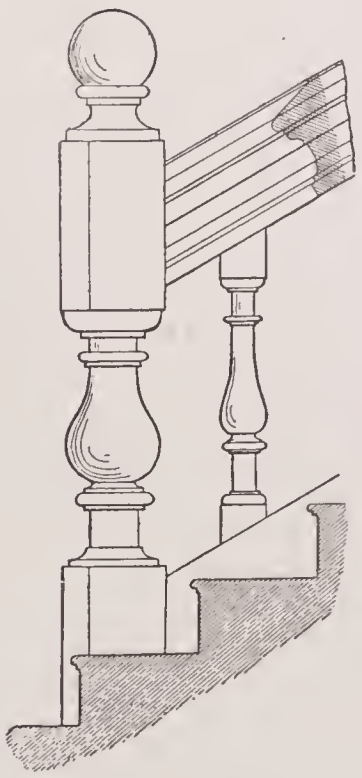
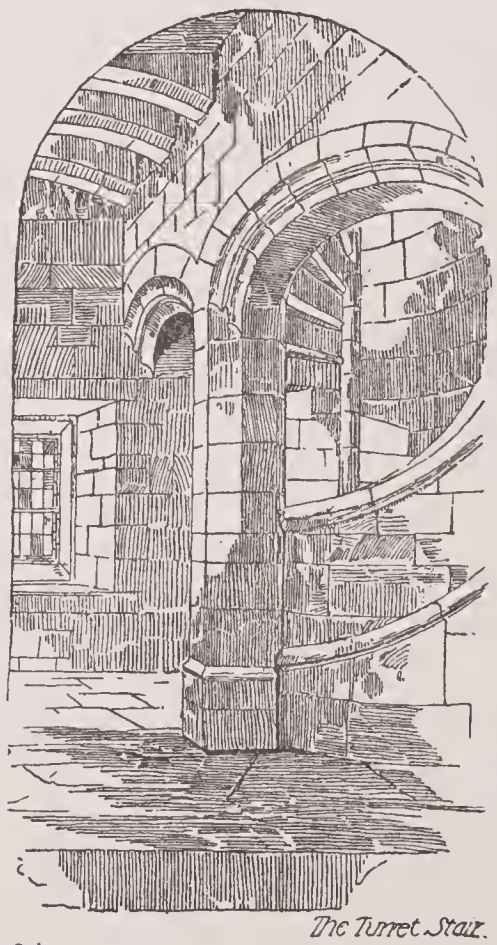


FIG. 6



The Turret Stair.
Naworth Castle, Cumberland, Eng.
From The Building News.

FIG. 7.

DEFINITIONS.

Stairs.—That mechanical structure in a building by which access from one story to another is obtained.

Staircase.—The whole structure, consisting sometimes of a number of connecting flights of stairs, and again of one flight only.

Well-hole.—The opening required for a complete staircase.

Right-hand and Left-hand Stairs.—A stair is called right-hand if, when a person is going up the stairs, the hand-rail is on the right; but if in going up a stair the hand-rail is on the left, then the stair is called a left-hand stair.

The Run of a flight of stairs is the horizontal distance from the first to the last riser in the flight.

Tread.—The horizontal distance between two risers. One of the equal divisions into which the run of a flight is divided.

Height of Story.—The vertical distance from the top of one floor to the top of the floor of the story above.

Head-room.—Height required to clear the head in ascending or descending stairs.

Rise.—The vertical height between two treads—one of the equal divisions into which the height of a story is divided.

Riser.—The board forming the vertical portion of the front of a step to which it is glued or otherwise fastened at right angles.

Step.—The horizontal plank upon which we tread in ascending or descending a stair.

Nosing.—The outer or front edge of a step. It usually projects beyond the face of the riser a distance equal to the thickness of the step, and is rounded or moulded.

Winders.—Steps of a triangular form in plan required in turning an angle or going round a curve.

Scroll Step.—A bottom step with the front end shaped to receive the balusters round the scroll of the hand-rail; also called a *Curtail Step*.

A Flight.—One continued series of steps without a landing.

A Landing.—A horizontal resting-place at the top of any flight.

A Half-turn Platform.—A landing extending across the well-hole, embracing the widths of two adjoining parallel flights as they land on and start from the platform.

A Quarter Platform.—A square landing, the sides of which each equal the width of its connecting flight.

Wall-string.—The string secured against the wall. A plank prepared by mortises sunk into its face to receive and house the ends of steps and risers on the wall side.

Front-string.—The string on that side of the stairs over which the hand-rail hangs; a plank prepared and sawed out to receive and support the front ends of steps and risers.

Open-string.—Same as front-string.

Close Front-string.—A front-string into which the ends of steps are housed the same as a wall-string, the upper edge of the string capped to receive balusters; and its outer face paneled or otherwise ornamentally finished.

Pitch.—Angle of inclination.

Pitch-board.—A piece of thin board in the form of a right-angled triangle, one of the sides of the right angle equal to a rise, the other side of the right angle equal to a tread of a stair. The hypothenuse is the pitch or angle of inclination of the stairs.

Cylinder.—A concave semicircle, formed by gluing together hollowed wooden staves, or by bending over a convex cylinder.

Quarter-cylinder.—A concave quarter-circle hollowed out of a solid piece of wood, or formed by being bent over a convex quarter-cylinder.

Splice.—Half the thickness of wood cut away for a few inches of its length, so that it can be joined to another portion similarly treated.

Facia.—A casing, finishing the face of beams—called headers—along the floor levels.

Fillet.—A band $1\frac{1}{4}''$ wide by $\frac{1}{4}''$ thick, nailed to the face of a front string below the cove or scotia, and extending the width of a tread; and also a similar band mitred with the riser. The fillet is also nailed to the facia under the scotia along the levels.

Curve-out.—A concave curve of the face of a front-string at its starting.

Board.—Merchantable sawed lumber of various widths and lengths, and *one inch thick or less.*

Plank.—Merchantable sawed lumber of different lengths and widths, and *more than one inch thick.*

Timber or Beam.—Sawed lumber of large size.

Carriage-timbers.—Permanent timber supports nailed under stairs parallel to the lower edge of strings.

Newel.—An ornamental post or column—built or turned solid—of various sizes and designs, set at the foot of stairs to receive and secure the hand-rail. In open-newel stairs, posts of a small size set at the angles and into which the strings are framed.

A Straight Flight of Stairs—Is one in which all the steps are parallel and at right angles to the strings.

Quarter-turn Winding Stairs.—A stairs in which the winders make a turn of one quarter to a landing or to a continuation of the flight.

Half-turn Winding Stairs.—A stairs in which the winders make a turn of one half to a landing, or to a continuation of the flight.

Circular Stairs—Are stairs with steps planned in a circle, toward the centre of which they all converge, and consequently are all winders. These stairs may have a circular, a square, or octagonal-shaped wall; and on the front an open cylinder and continued hand-rail, or a solid circular post with the front ends of steps and risers housed into the post.

Elliptic Stairs.—Stairs that are elliptic on the plan. The treads are spaced on the front and wall strings, but being less in width on the front-string, they all converge, but not to one centre like those of a circular stairs.

Newel Stairs.—Stairs in which newels are substituted for cylinders and continued hand-rail.

Open-newel Stairs—Are so called because they have small newels arranged at the angles of an opening in place of cylinders. The connecting front-strings are framed into the newels.

Hand-rail.—A variously-moulded form and size of rail running parallel to the inclination of a stairs, and usually kept at a vertical height of $2'.2''$ from the top of step to the bottom of rail, at the centre of short balusters. The rail also continues around cylinders, or connecting with newels parallel to floor levels, at a height of $2'.6''$ * from floor to bottom of rail.

Baluster.—A small column made of different forms and sizes, but commonly turned. They are set vertically on the steps of stairs, generally two on a step, and placed the same distances apart on the floor levels, forming an ornamental enclosure and furnishing support for the hand-rail.

Balustrade.—Balusters and hand-rail combined.

Wreath.—The whole of a helically-curved hand-rail, whether it makes a half-revolution or more.

Wreath-piece.—A portion of a wreath less than the whole.

Face-mould.—A section produced on any inclined plane vertically over a curved plan of hand-rail; including also in the same plane with the face-mould tangents to a central curve-line of the plan. Joints of face moulds are made at right angles to these tangents.

Ramp.—A concave or convex curve or easement of an angle, as sometimes required at the end of a wreath, and the adjoining straight rail, where the two have different inclinations.

Ramp and Knee.—A concave easement of hand-rail with its upper end forming an angular knee. When the knee is curved convex the combined curves are called a *Swan-neck.* These two forms—ramp and knee, and ramp and swan-neck—are used in open-newel and other stairs where the newels are turned.

Butt-joint.—An end joint made at right angles to the central tangent of a wreath-piece; and also an end joint made at right angles to any straight length of hand-rail.

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* In figuring measurements of architectural drawings, and in specifying sizes, feet and inches are designated by accent-marks—called indices—as follows: $2'.6''$ meaning two feet six inches. Feet are denoted by one accent-mark over the number, and a period on the right separating it from the fractions of a foot,—inches Inches have two accent-marks over the number as shown. Feet and no inches are indicated thus: $25'.0''$—twenty-five feet no inches; inches and no feet thus: $0'.6''$—no feet six inches. The latter is frequently written with the indices for inches only, as $6''$.

BOOKS PUBLISHED TREATING ON STAIR-BUILDING.

THE following is a complete list and dates, as far as ascertained, of publications in the English language that either treat partially or wholly of stair-building and hand-railing:

DATE.

1693. Moxon, "Mechanical Exercises."
1725. Halfpenny, "Art of Sound Building."
1735. Francis Price, "British Carpenter."
1738. Batty Langley, "Builder's Complete Assistant."
1750. Abraham Swan, "Architect."
1792. Peter Nicholson, "Carpenter's Guide."
1813. Peter Nicholson, New "Carpenter's Guide."
1826. M. A. Nicholson, "Carpenter, Joiner, and Builder's Companion."
1864. Joshua Jeays, "Orthogonal System of Hand-railing."
1873. Newland's "Carpenter and Joiner's Assistant."

The above are all English publications. The following are all—or have been—published in the United States:

DATE.

1844. R. G. Hatfield, "The American House-carpenter."
1845. Simon De Graff, "The Modern Geometrical Stair-builder's Guide."
1849. Cupper's "Hand-railing."
1856. Robert Riddell's "Hand-railing."
1858. Perry's "Hand-railing."
1859. Esterbrook & Monckton's "American Stair-builder."
1872. Monckton's "National Stair-builder."
1875. Gould's "Hand-railing."
1887. Monckton's "Stair-building in its Various Forms, and One Plane Method of Drawing Face Moulds and Unfolding the Centre Line of Wreaths.."

SUGGESTIONS.

The Attention of Teachers Engaged in Giving Instruction in Architectural Drawing in Technical Schools is Invited to the Examination of this Work, which is believed to be well suited for taking up an important part of interior use and decoration—the planning and construction of stairs, a branch of building but slightly touched, while roofs and other parts of building structures are taught in much detail.

Apprentices who desire to master the contents of this book are informed that much care in its preparation was given to make the whole so simple and clearly stated, that it would be easy to learn; yet if any have had no previous practice in the use of drawing-instruments, and no knowledge of practical geometry, such should at once begin that study. *A notice of a little book of Practical Geometry, treating likewise of the use of instruments and all the necessities of a beginner in the study of drawing, will be found in the last pages of this work.*

In the Study of Hand-railing the paper formed solids beginning with Plate No. 10 should be drawn as directed, cut out, and glued in shape as explained; for this purpose a little bottle (with brush) of LePage's liquid glue is best and most convenient.

The Squaring of Model Wreath-pieces, one quarter of full size—or one half size in case of small cylinders—out of some soft wood brings valuable results to the apprentice, of which the first is *Practice;* second, *Experience;* third, *Knowledge.*

Fitting Wreaths over Circular or other Curved Iron Staircases.—Begin by chalking on the iron hand-rail plate suitable lengths of wreath-pieces; and to get a parallel pattern for each of these pieces, press a thick, strong sheet of paper to the top of the plate, and mark the concave and convex edges of the plate as far as the length requires; parallel to the curves thus marked set off each side enough to make the width equal that given by trial at Figs. 6 or 7, Plate No. 56, and a half-inch more each side of the centre; but make the thickness of plank as found at the last-mentioned plate and figures; cut the paper joints to suit the eye, and a little long. These paper patterns are used to mark the shape of the wreath-pieces on the plank; they are then sawed out square through. The bottom of the wreath-piece is first fitted to the iron plate and the plate let in flush; then plumb-lines are put on the joints, the sides worked plumb and brought to a width; lastly the top is cut away to the thickness, and the joints finished; when the adjoining pieces are squared, their joints are fitted against the first piece, etc.

Note.—*Fitting wreaths over iron staircases on iron rail plates is done as above directed because the curves to which the iron is brought are often various and eccentric, consequently fitting is resorted to as quickest and best.*

Self-supporting Circular Stairs are rarely built. These stairs stand disconnected and away from walls or any points of support, except at the top and bottom, and have hand-rails and balusters over both strings. No carriage-timbers need be used if the risers are increased in thickness and the strings are made thick and bent laminated as explained at Plate No. 8, Fig. 5. The strings at the bottom should be run down between the floor-beams and secured with strong iron bolts; they should also be strongly bolted at the top. Only screws ought to be used on such a staircase. Jib panels should be built as high as can be permitted under the strings at the foot of the stairs. *The management of hand-railing for circular stairs is given at Plates Nos.* 53 *and* 54.

Close Paneled Strings are best suited to neweled stairs, but if this construction is used with cylinders they should be of large diameter, otherwise the work will appear cramped and ugly.

The Joints of All Wreath-pieces with the exception of those given at Plates No. 34 and 35 must be made at right angles to the face of the plank.

Newel Caps Mitred to Hand-rails ought to be abolished.

Turned newels should be finished in one solid piece. The connection of hand-rail with newel is stronger and better if run straight to the newel and bolted together.

Balusters with Square Bases insure a stronger balustrade than those with circular bases.

Hand-rails may be Finished and Varnished before being set up, if reasonable accuracy be observed in the drawing and in the work.

PLATE 1.

PLAN AND ELEVATION OF A STRAIGHT FLIGHT OF STAIRS WITH A SEVEN-INCH CYLINDER; ALSO A PLAN AND ELEVATION OF A PLATFORM STAIRS WITH A SIX-INCH CYLINDER LANDING WITH FOUR RISES ABOVE THE PLATFORM.

Fig. 1. Plan of a Straight Flight of Stairs.—The plan is given to show the width of the stairs, the size and position of the cylinder, the number and position of the rises and treads ; also by means of the shaded lines to show the opening of the well-hole, its width and length ; its width sufficient to receive the width of stairs, the diameter of cylinder and the thickness of facia ; its length sufficient for head-room.

Fig. 2. Elevation of the Straight Flight of Stairs Shown by Plan at Fig. 1.—The number of rises is determined by dividing the height of story—taken from the top of the floor of the lower story to the top of the floor in the upper story—into any number of suitable parts ; in this case the height of story is 10′.4″, equal to 124″, which divided by 16 gives a quotient of 7¾″, the height of one rise. In the above manner the height of any given story must be taken and divided into any number, more or less, of rises. The rod E F shows the manner of taking the height and the division of rises. To obtain the tread,* first find the horizontal distance that can be taken for the run of the stairs and landing room ; which in this case is equal to A D, 14′.5″; of this the landing room, B D, must never be less than the width of the stairs, and is always better several inches more ; therefore take B D, 2′.9″, for landing, and C B, 5″, for depth of cylinder ; leaving A C, 11′.3″, to be divided into treads. There is always one tread less than the number of rises in each flight of stairs, because the floor itself becomes a step for the top rise ; so having sixteen rises in this flight, the remaining 11′.3″, equal to 135″, must be divided into fifteen parts, which equals 9″ for each tread, as shown at plan and elevation. The line G H is the lower edge of the string-plank, which plank is sawed out to receive and make a finish with the risers and steps. The dotted lines parallel to G H indicate the position of the supporting carriage-timbers. Head-room is secured by constructing the well-hole of a sufficient length so that the tallest person in ascending or descending the stairs would not be in danger of striking the head. Head-room should not be less than 7′.0″. It is not necessary to draw an elevation of steps and rises to determine head-room, for that can be learned from the plan at FIG. 1 ; for example, count thirteen rises from the top down at J ; thirteen rises, 7¾″each, equal 8′.4¾″ ; subtract from this the thickness of floor, depth of beam and plaster, altogether 10¾″, and there will remain 7′.6″ for head-room,—if the length of the well-hole does not cover the step J, FIG. 1.

Fig. 3. Plan of Platform Stairs.—Platform stairs ascend from one story to another in two or more flights, having platforms between for resting and changing their direction. This plan has but one platform, taking the whole width of the hall, and has four rises in the upper short flight and thirteen rises in the lower starting flight. The shaded lines show the framing of the open well-hole, including the platform.

Fig. 4. Elevation of Platform Stairs from the Plan Fig. 3.—I J is the height-rod showing the division and number of rises.

The head-room and tread are found as before explained at FIG. 2. Some attention must be given to the position of platform K, so that the height underneath has sufficient head-room and clears the trim or fan-light of doorway, if there be any ; for the platform may be one or more rises higher if space can be spared to add one or more treads to the starting flight—these treads to be taken from the short landing flight. At L is shown the starting of a second flight from that floor.

A Rule to Find the Correct Proportion of Tread to Rise.—To any given rise in inches add a sum that together will equal twelve, double the sum added to the given rise for the tread in inches,—as follows : given a 5″ rise and 7 make 12, then twice 7 equals the required tread, 14″; or again, given a 7″ rise and 5 make 12, then twice 5 equals the tread, 10″, etc.

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* The tread is the distance between risers, as M N FIG. 2, without including the projecting nosing ; when the projection of the nosing is added the whole is called the step. The projection of the nosing is usually made equal to the thickness of the step.

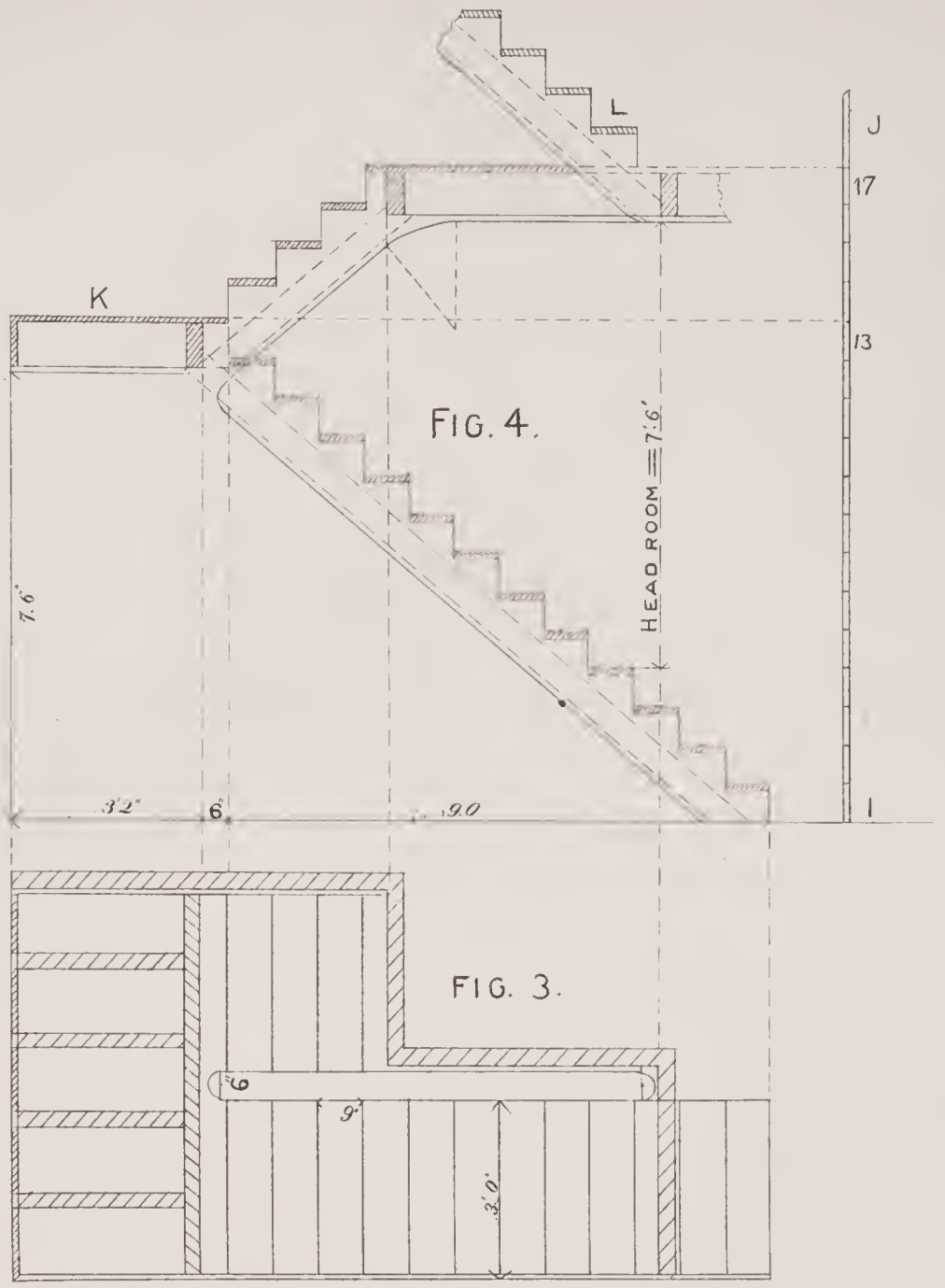

FIG. 4.

FIG. 3.

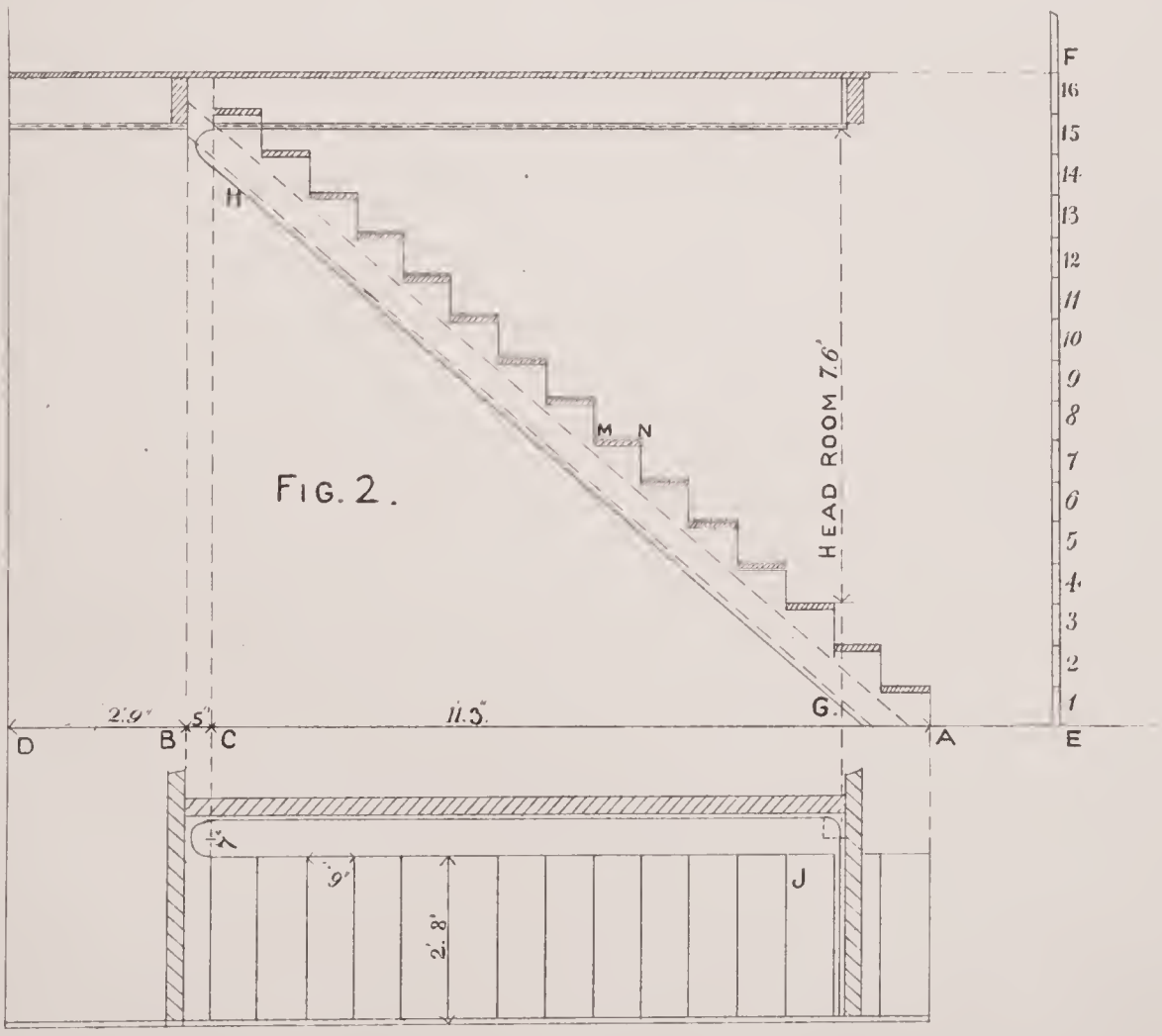

FIG. 2.

SCALE $\frac{1}{4}$ IN. = 1 FT.

FIG. 1.

PLATE 2.

Stepladders and Stoop.

Fig. 1. Plan of Stepladder.—This plan shows the thickness of the sides, the width of the ladder, the treads and number of rises, also an extra width of tread, as at P Q, which should always be allowed at the top step of a ladder.

With P Q, 3½″ deducted from the run P M, there remains Q M, equal to 3′.6½″, or 42½″, to be divided by 10, the quotient of which is 4¼″, the tread. The point of the ladder N M, if desirable, may be cut off on the line N O, and glued and nailed to the back edge of the ladder, keeping the point V to the floor.

Fig. 2. Elevation of Stepladder given at Plan Fig. 1.—The height from floor to landing above is 8′.1½″, which divided by 10 gives a quotient of 9¾″, the height of each rise. The sides of stepladders having from ten to fifteen rises should be from 5″ to 7″ in width and not less than 1⅛″ thick. One way to lay out the sides of a stepladder is as follows: let T R equal the tread and R S the rise; connect T S; take the distance T S in the compasses and mark on the edge of the side of ladder from V to A ten spaces, and with a bevel (as at X taken from T) lay out the angle and thickness of steps as shown. Another way to lay out the sides of a stepladder is to use a steel square (as at B), placing the square at the edge of the ladder to the height of rise and width of tread as figured on the square and as many times as there are to be rises in the ladder. The steps should be let into the sides of a ladder from ⅜″ to ¾″; ⅜″ will be sufficient if the sides are 1″ thick.

Steps are set into the sides of a ladder (as at Z Y) when the sides of ladder are 9″ or 10″ wide and 2″ or 3″ thick, as sometimes built in buildings used for wholesale stores.

To make a small movable stepladder strong and keep the steps from working loose a tenon should be run through the sides at three points (as at 1, 2, 3) and properly nailed.

Figs. 3 and 4. Plan and Isometrical Elevation of a Double Stepladder.—Where space is limited and only occasional communication between stories is necessary, this ladder will answer the requirements, as it can be constructed in the cheapest manner and put up in mere closet-room. Hand-rails should be put up at both sides of the ladder, hung on iron brackets well secured in the wall, by the plan at Fig. 3 and its perspective. At Fig. 4 there are shown fifteen rises of 8″ each, making a total height of 10′.0″; and fourteen treads of 9″ each, occupying a run of 5′.3″.

Fig. 5. Elevation of Stoop with Platform.—The newel-post and balusters have no turned work, but are cut on the angles and chamfered.

The strings where there are so few steps may be laid out with a steel square, or can be laid out with a pitchboard in the same manner as inside stairs. Fig. 6. A pitchboard, to be made of thin, well-seasoned wood, N M O, must be made perfectly square, M N the tread and M O the rise. The grain of the wood should always run in the direction of N O. The edge of the string C should be jointed, and a pencil-gauge distance equal to C D run along from the edge C.

The distance C D is equal all together to depth of timber, thickness of riser, and thickness of ceiling boards underneath. Along the line C the pitchboard is marked on the stuff as many times as there are to be rises, and then sawed square through on the line of treads, and cut mitring on the line of rises. The dotted lines show the correct position of the hand-rail to determine its exact length; the platform level rail is raised 4″ above the platform, so that when the rail at the centre of the short balusters along the flight is raised the usual height, 2′.2″, the level rail over the platform will be 2′.6″, the usual height for a level rail. At the newel G H is raised 3½″, which added to 2′.2″—the height at the centre of the short balusters—makes the height G K at newel 2′.5½″.

Note.—The whole of the above practical details and directions relating to an ordinary stoop apply equally to inside stairs where similar work is required.

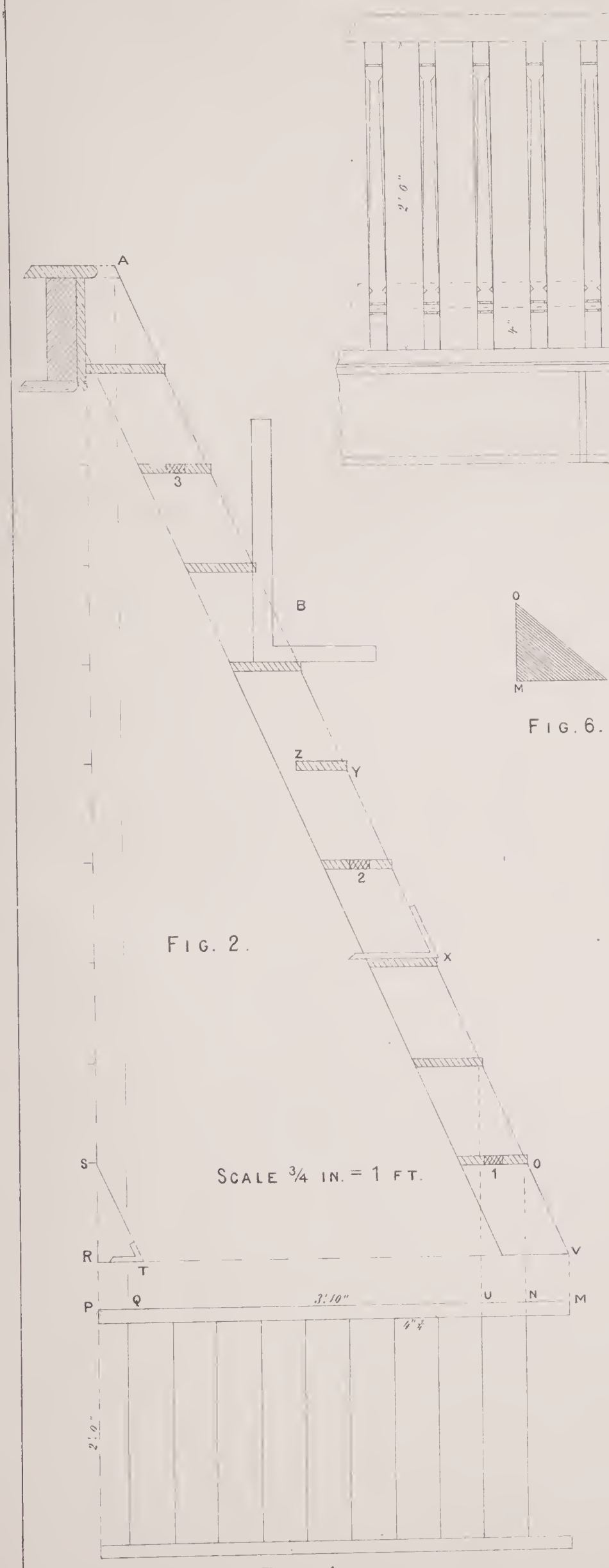

FIG. 1.

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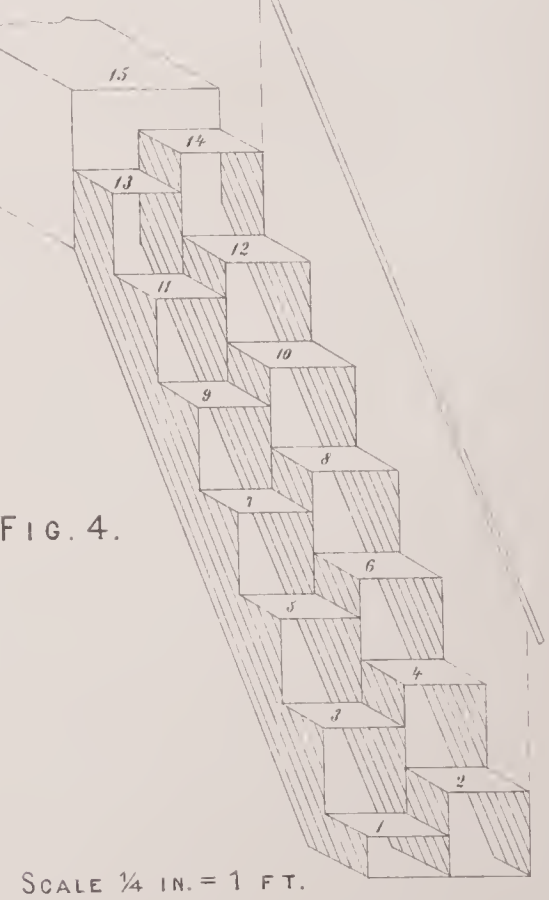

FIG. 4.

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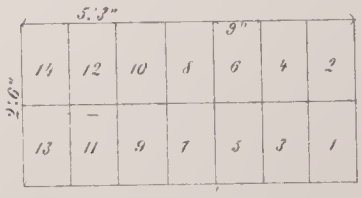


FIG. 3.

FIG. 6.

FIG. 5.

SCALE ¾ IN. = 1 FT.

PLATE 3.

PLAN, ELEVATION AND DETAILS OF A COMMON STRAIGHT FLIGHT OF STAIRS.—STAIR-BUILDING GENERALLY.

Fig. 1. Plan of a Common Straight Flight of Stairs; showing the width of the flight, the thickness of wall-string, the width of treads and number of treads and rises, the position of the balusters, the cylinder, the width and place of hand-rail and size of newel-post.

Figs. 2 and 3. Methods of Forming Cylinders and Splicing them to Strings.

Fig. 4. Wall-string Laid Out, showing easements of angles joining floor-base at starting and landing, mortises laid out with wedge-room for steps and risers which are to be let into the string 5/8".

Fig. 5. Front-string Laid Out.—A B must be sufficient for depth of timber, thickness of plaster and of riser. The dotted lines at C show the wood to be left on the string for cylinder-splice. G F H D E is the cylinder opened out; F G must be the depth of floor-beam and thickness of plaster; the line D E G is the bottom edge of the cylinder, and at E the curve is raised somewhat above the direction of the line A D in shaping the edge, so as to prevent a baggy appearance the cylinder would otherwise have when in place.

Fig. 6. Step and Riser as Glued Together.—The whole thickness of the riser is let into the ploughed groove of the step 3/8"; J is a glue-block, of which two or more are glued and nailed in place as shown along the length of step and riser. K K are dovetail mortises cut in the end of steps to which the balusters are fitted, glued and secured in position as shown at FIG. 8. The step and riser are backnailed together as at R; from two to four nails are driven in, depending on the length of steps.

Fig. 7. Stair-timbering and Rough-bracketing.—This drawing represents a vertical section cut through the middle of a flight—a plan of which is given at FIG. 1—showing an end view of steps and risers, rough board brackets L L, the middle timber M, and plaster N. Stairs 3'.0" wide and less are usually provided with two carriage, or supporting, timbers, one of which is used to strengthen the front-string, this string being securely nailed to the timber; the other timber, M, is placed at the centre of the stairs and rough board brackets, L L L, fitted and nailed as shown at alternate sides of the timber. At S the nail through the rough-bracket is driven into the back of the step.

Fig. 8. Side Elevation of the Starting Portion of Stairs, a Plan of which is Given at Fig. 1.—The hand-rail is brought straight to the newel at Q, as being a stronger and better connection in many ways than the old plan of a loose turned cap and easement of rail mitred to the cap. P is a jib panel which is usually made as a finish to the bottom of a first-story flight, and also to receive the level rail, O, that encloses the basement-stair well-hole. There is no better or stronger method of building wooden stairs than what is here described in detail, where each step and riser are glued together in the manner shown at FIG. 6, and housed and properly wedged with glue and hard-wood wedges in the wall-string, as shown at FIG. 4,—also housed and wedged in the same manner at the front, if a close front-string is used. Carriage-timbers, rough-bracketed as before described at FIG. 7, of a size from 2" by 4" to 4" by 10", and from two to five timbers—never less than two—to each flight, depending on the width and extent of the stairs and the weight they are expected to carry.

For good substantial work well-seasoned materials should be used throughout. So important is this considered in the larger-sized timber that old second-hand timber is sometimes sought for. Whole flights of stairs—with the exception of circular, elliptic, or some other peculiar form—are most economically finished by being wedged and nailed together, trimmed and raised to their places in the building complete; the supporting timbers are easily put in position afterward. Generally the staircase may be put up on the dry brown wall, and if made of hard wood the steps, risers, strings and newels may be completely covered with cheap heavy brown paper and thin rough boards, to remain as a protection until the walls are finished with white plaster, the doors hung, the mantels and grates set.

This covering when put on may be so arranged as to enable the stair-builder to easily remove some six inches of it, enough to allow the hand-rail to be put up and finished, leaving the balance of the covering until no longer required.

A Staircase of Any Form of Plan may be Finished on the Under Side, Showing its Construction with far more elegance and variety than any surface plastering or close panelling commonly done. In this finish the wedged strings will have to be cased to conceal the wedging. Both the wall and front strings should have greater thickness than usual; the front-string should be thick enough to dispense with a front carriage-timber, or such timber may be used and cased. If desirable the risers can be made of a thickness and strength that no middle supporting string or cased carriage-timber would be required: this would leave an unobstructed view of panelled steps and risers, or other ornamental finish.

The Old English Method of Stair-building—which is occasionally followed in this city, and commonly in some portions of the United States—is to construct rough timber carriage-ways sawed out for step and riser, with rough steps nailed on, to be used for travel during the process of building, and to be plaster-finished as required on the under side, at the same time with the walls of the building. This carriage-way is then cased with finished strings, steps and risers; the wall-string and sometimes the front-string—where the latter is to be close—are scribed to the grooved step and riser and set in this groove with a 3/8" tongue; the projecting step nosing is sawed to fit against the face of the scribed string. *This last method of building the bodies of staircases is not as good as the more modern one previously described, and is also much more costly.*

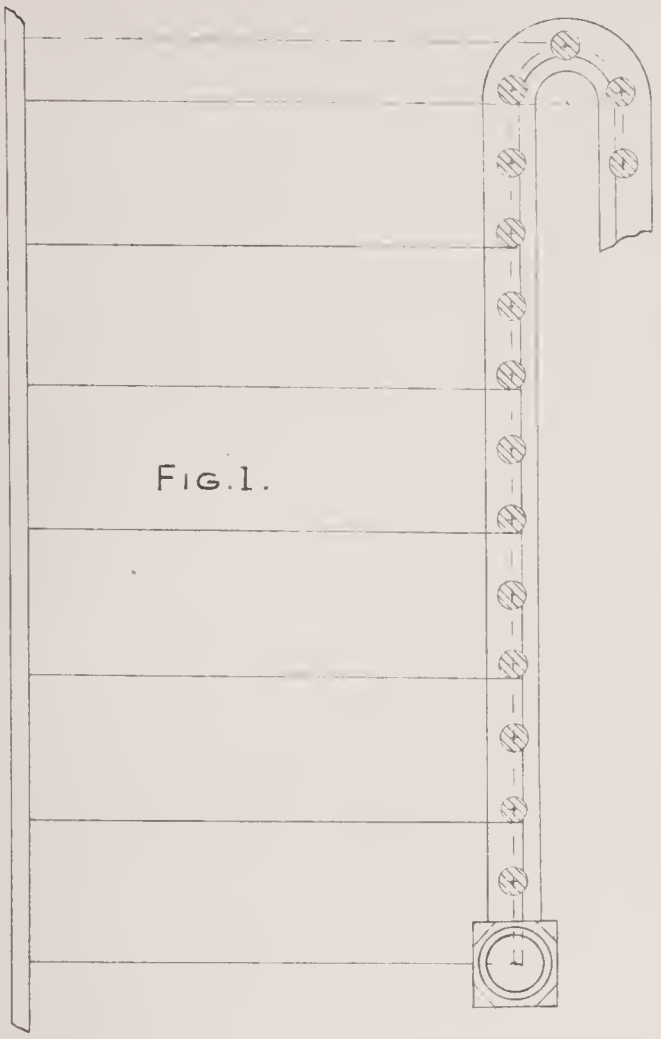


FIG. 1.

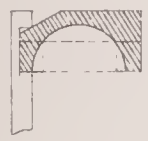


FIG. 2.

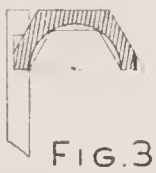


FIG. 3

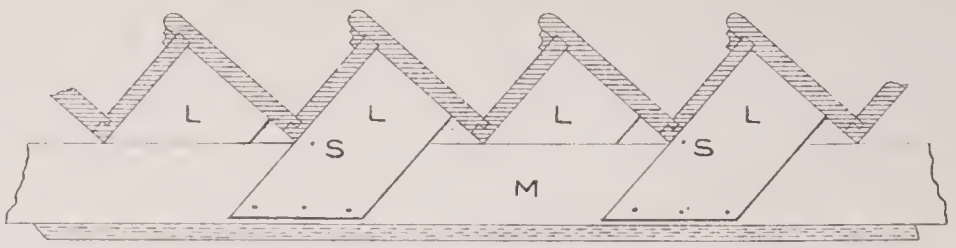


FIG. 7.

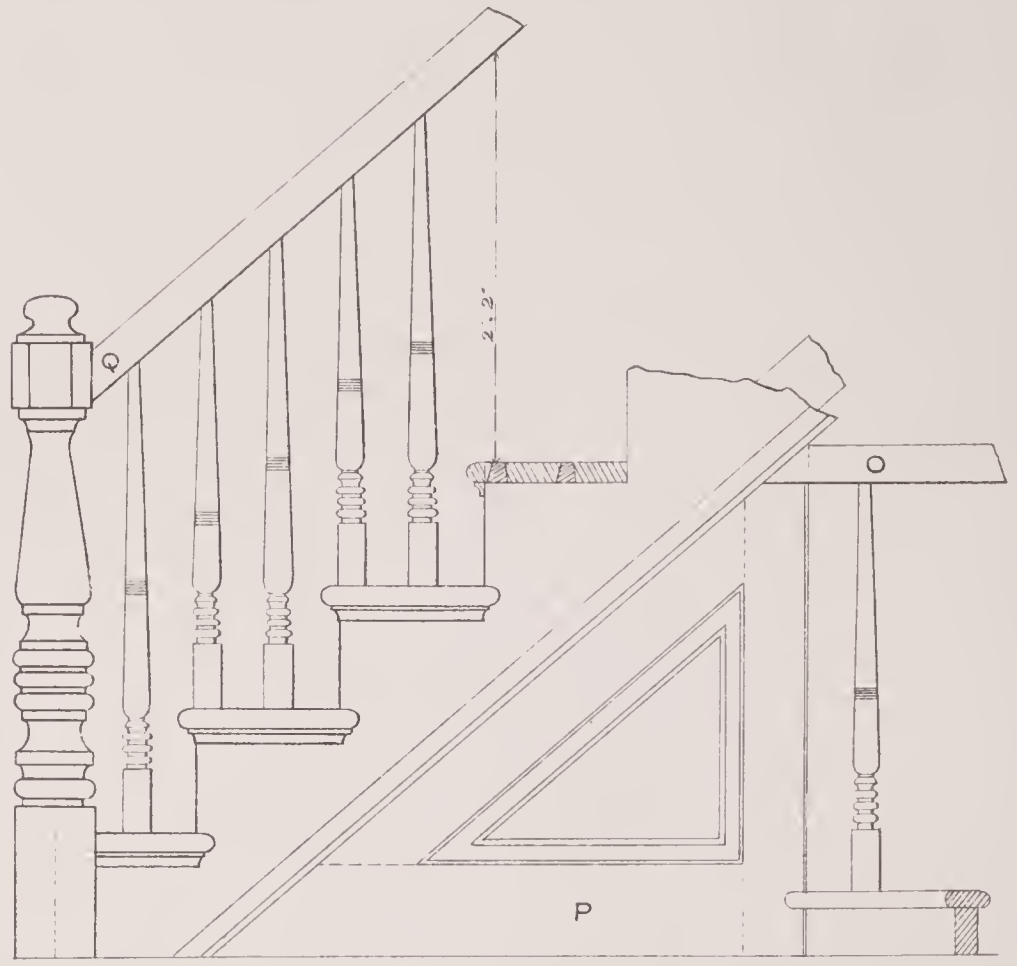


FIG. 8.

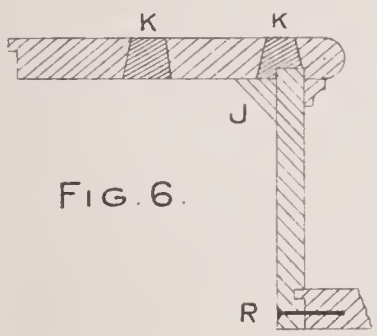


FIG. 6.

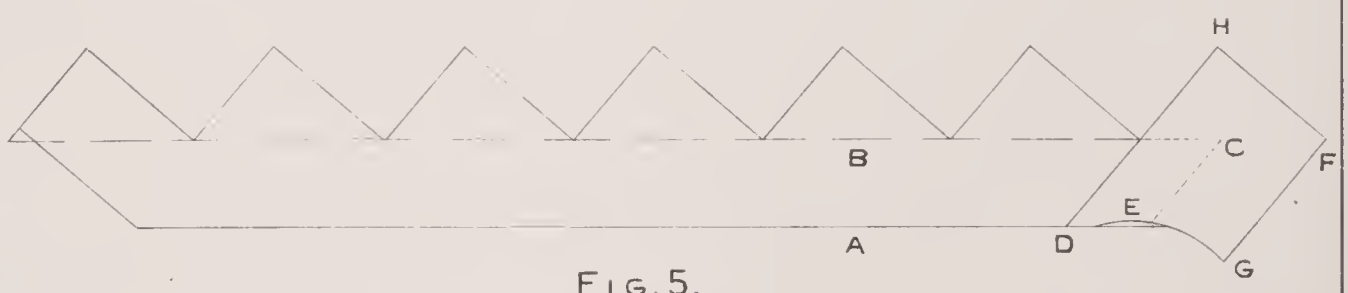


FIG. 5.

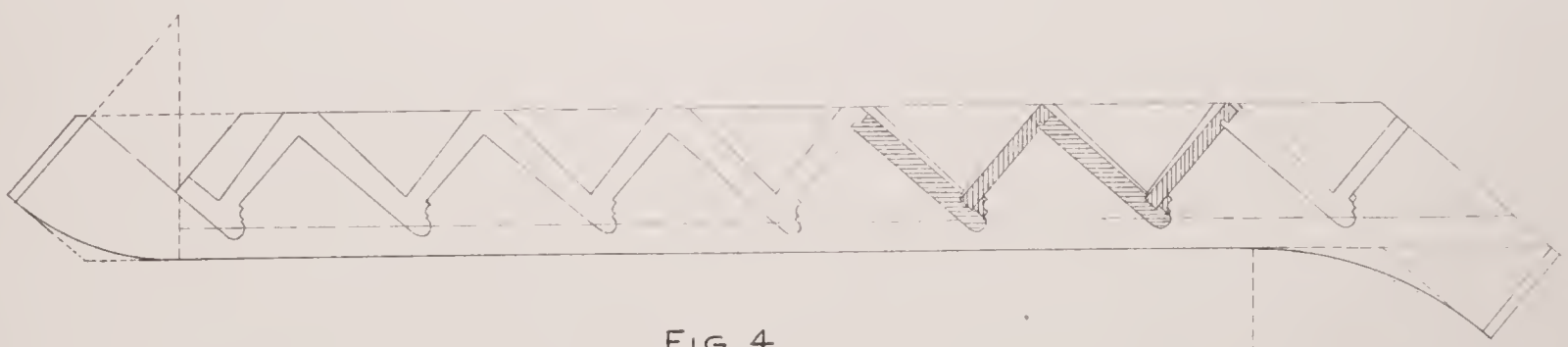


FIG. 4.

SCALE $\frac{3}{4}$ IN. = 1. FT.

PLATE 4.

PLANNING WINDING STAIRS—DRAWING ELEVATION OF THE SAME—LAYING OUT THE STRINGS.

Fig. 1. Plan of a Staircase Winding One Quarter, Alike at the Top and at the Bottom, with Cylinders 10″ in Diameter.—It is important in planning winding stairs of various forms—and this example will serve for all—to make the treads as nearly as possible of a uniform width on an established line of travel, which is about 14″ from the front-string as shown. It is well to increase the width of the stairs a few inches both at the top and at the bottom, for the more convenient passage of furniture at these turns. In making the plan of stairs, the first thing to be determined is the wall-lines A B C D, next the width of the body of the stairs from the wall E to the front-string F. The width of the hall for this staircase will require to be 7′ between rough walls—3′.0″ width of stairs, 10″ diameter of cylinder, 3′.0 passageway, and 2″ thickness of plaster. From the walls to the cylinder, at both the top and the bottom of the stairs, the width is made 3′.2″. The line of travel is drawn in position as before mentioned ; the starting or first and top or landing riser lines are now drawn as required, taking care that not less in any case than 2″ level of the cylinders, as at X X, be left at both top and bottom so as to make a proper finish with the facias. Between these starting and landing risers, on the line of travel, equal spaces are marked for the width and number of treads required ; next the treads in the cylinders and along the line of the front-string are marked as figured ; now the lines of risers are drawn from the points of division at cylinders and front-string, through the points of division first made on the line of travel : and this completes the plan.

Fig. 2. Elevation of the Plan of Stairs, Fig. 1.—This elevation explains itself in connection with the plan beneath : The important points given by the elevation are the head-room from the top of the third step, G, to the plastered ceiling, H, and the length of the well-hole as limited and shown by the line G H. It is not necessary to set up an elevation of a staircase to fix the head-room. The head-room may be determined, and the length of well-hole, by finding how many rises down from the top—after subtracting therefrom the depth of floor-beam, including floor and plaster—would equal in height 7′.0″, or very nearly that.

Fig. 3. Laying Out of the Front-string and Cylinder.—The distance K J, on the front-string, must equal all together the depth of timber, thickness of plaster and thickness of riser. The cylinders are spliced to the string on the lines O P and R S ; the treads, as given in the cylinders and string, agree with the plan FIG. 1. At the starting cylinder, N X equals 10″, the width of facia, which is the depth of floor-beam (9″) and thickness of plaster (1″). The top cylinder requires a straight piece of board the thickness of facia glued at its upper end, of sufficient width and length (as at T X V U) to produce an easing between the lower edge of the cylinder and the lower edge of the facia ; this piece is glued to the cylinder on the line T X, and joins the facia on the line U V. The depth to the lower end of the cylinders is found, as shown, by describing arcs of a radius equal to K J from the angles of tread and rise as shown at Q O and W T. It is better to join the cylinder as at R, on the straight line R K, even if it has 2″ or 3″ more depth at that point than at K J. *Cylinders are sometimes—generally in the best work—laid out with the straight string in one plank, as here shown, and the whole of that portion for forming the cylinders up to the lines* O P *and* R S *is cut away at the back, leaving only a thin veneer at the face, which is bent over a convex cylinder and filled out with staves, as described at* FIG. 4, PLATE 8.

Fig. 4. Wall-string.—This string is the starting portion, A B, at the plan FIG. 1. In preparing this string to join the floor-base, V S is the height of base, then S L is the easing of the angle of string to the level of the base ; or the string may be mitred to the base, as at Y O, R Y being equal to V S. The height of string M N above the angle-step must be alike from the same step as M N at the next string, FIG. 5 ; also the strings connecting at these angles may be brought to a level, curved as shown, or left angular ; *but they must in all cases be brought to a level, so that the base-mouldings will properly connect.*

Fig. 5. Wall-string.—This is the whole of that portion of wall-string marked B C of the plan FIG. 1. The height of the string at O P must be alike from the same angle-step as at O P of FIG. 8. This string is laid out in two pieces spliced together at the centre, Z D ; it may be laid out in one piece by the use of a mean tread, and in another way, each of which methods will now be given.

Fig. 6. Wall-string same as Fig. 5, Laid Out in One Piece by the Use of a Mean Tread.—A mean tread is found by adding together the ten treads as figured, and dividing their sum by the number of rises (9), as follows : $25+17+13+9+9+9+9+13+17+23\frac{3}{4}=144\frac{3}{4}\div 9=16\frac{7}{64}+$″ mean tread, which is nearly 16⅛″. Along any line, A B, beginning at A, apply the mean tread, A C, and the rise, C D, as shown, marking each tread in their order of the width required, and if the work has been correctly performed the last tread, 25″, will come out at B of the line A B.

Fig. 7. To Lay Out Winder-strings from a Scale Drawing.—Set up to a scale of 1½″ to 1′ an elevation of treads and rises the same as at FIG. 6, and draw a line touching the outermost points of the upper edge of string, as X E O ; then with a bevel set to the angle Q O S a string may be laid out full size whose points X and E will touch the edge of plank. Begin laying out with the line O S, and make O S as many inches full size as it measures on the scale.

Fig. 8. Wall-string.—This string is the landing portion of wall-string marked C D on the plan FIG. 1.

PLATE NO. 4.

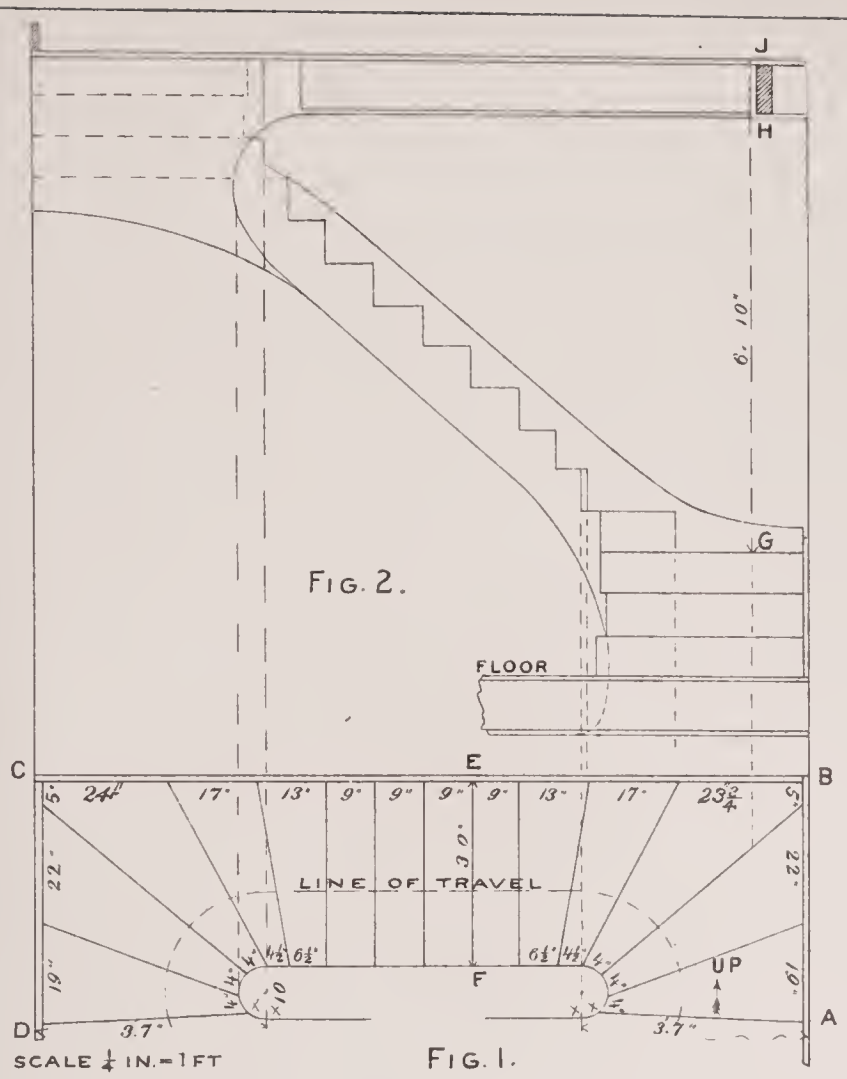


FIG. 2.

FIG. 1.

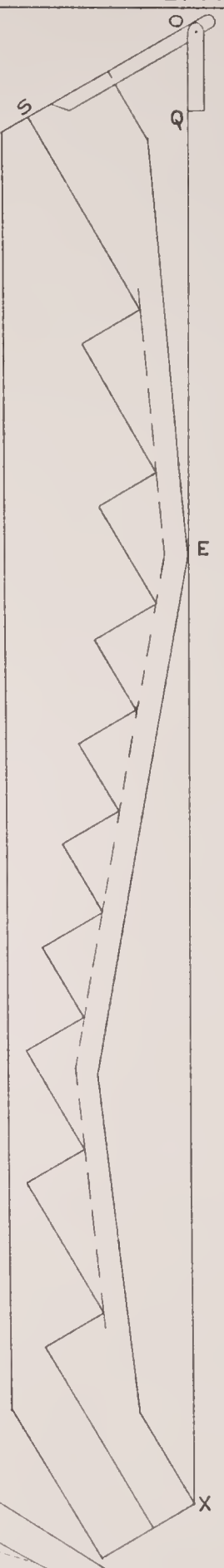


FIG. 7.

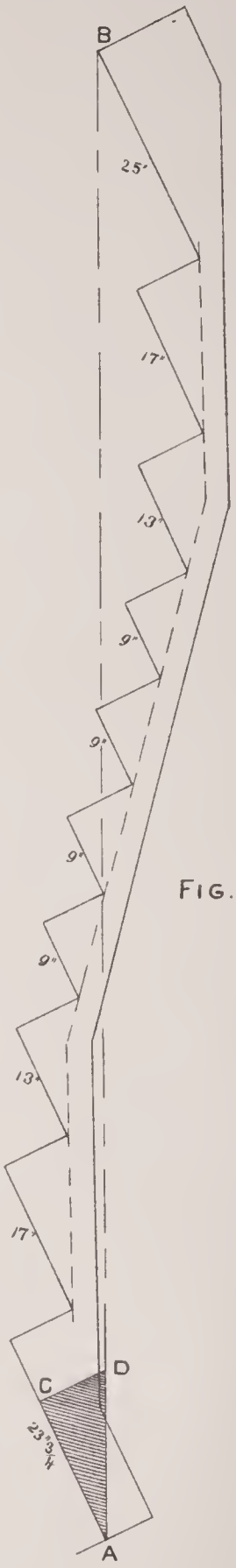


FIG. 6.

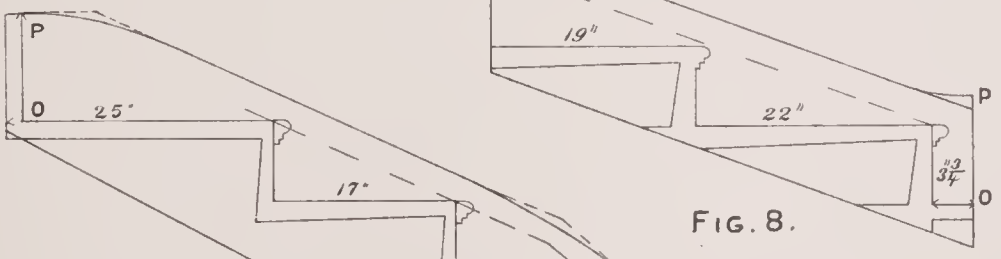


FIG. 8.

FIG. 5.

FIG. 4.

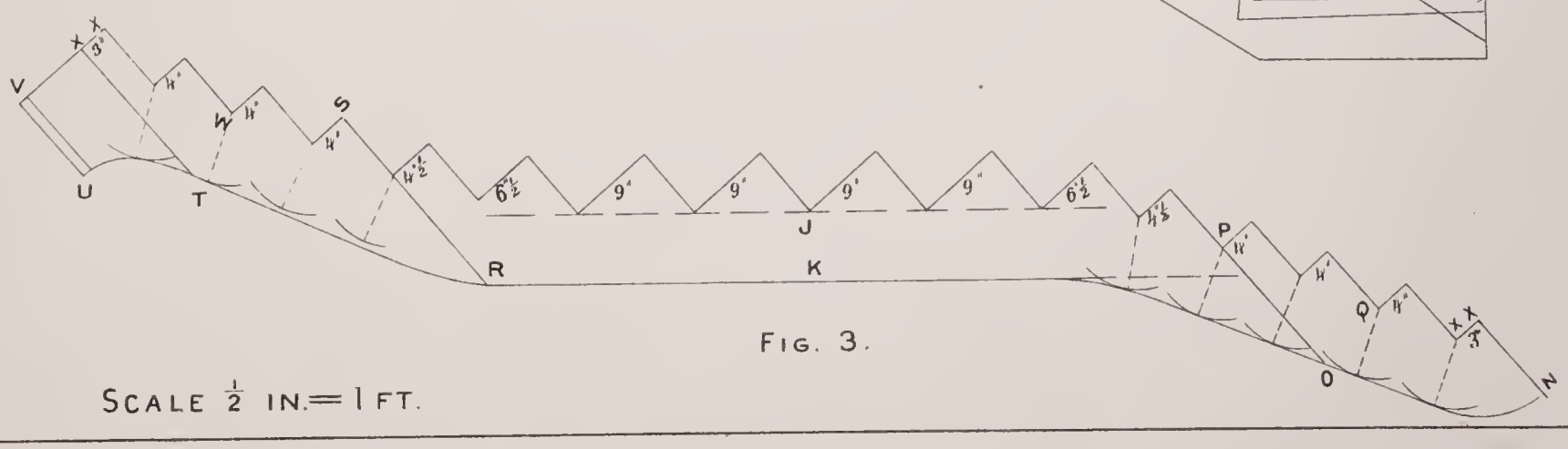


FIG. 3.

SCALE ½ IN. = 1 FT.

PLATE 5.

Through the drawings given in this plate and the two following plates, over thirty different plans of stairs are presented ; they are all made to a scale and figured for convenient reference. These various plans are intended to afford opportunity for the examination and study of stair plans, properly arranged for their different requirements. The grading of treads next to the cylinder in the case of winders, so that the wreath will make easier curves and less inclinations in its connections, is a matter of no slight importance. A little more attention, a better knowledge of practical details in planning stairs, will often lead to saving valuable space, or to a more comfortable passage from floor to floor. A superior plan of stairs may even prove to be a question of humanity ; a cruel thing it may be to a little child or an aged and feeble person to subject them to the danger and discomfort of travelling over oblique winding steps ; as, for example, at FIG. 5, when a very little more space, as figured, will permit a safe and easy stairway for all, as shown at FIG. 6.

Fig. 1. Plan of a Straight Flight of Stairs Starting and Landing with Small Cylinders.—The position of cylinders with regard to starting and landing risers, as shown in this case, is explained in detail at PLATE No. 22, FIGS. 1 and 2.

Fig. 2. Plan of a Straight Flight of Stairs Starting with a Newel Set-off 2½″ and Landing with a 7″ Cylinder ; the Landing Riser Set Into the Cylinder 2½″.—The set-off of a newel and its management in connection with the hand-rail is given at PLATE 31, FIGS. 1 and 2. The cylinder at the landing is treated in detail at PLATE 33.

Fig. 3. Plan of Winding Staircase with Mortised Strings Both Sides.—These stairs are only used where room for better cannot be spared, in such places as an attic or basement story. A and B are plank continuations of string 5″ wide and long enough when spliced to the mortised string at the top and at the bottom to receive the winding steps and risers, which will be better understood by examining the elevation of string set up at FIG. 4.

Fig. 5. Plan of the Top or Landing Portion of a Quarter-turn Winding Stairs, with a Small Cylinder.—The management of the hand-rail of this case is given at PLATE 25.

Fig. 6. Plan of the Top Portion of a Staircase Turning One-quarter to the Landing, with Diminished Steps Around the Cylinder ; Curved Risers and Platform.—This plan is an improvement on that given at FIG. 5. By curving the risers, winders are avoided and a roomy platform secured with the same small cylinder. But with the number and width of treads alike, this plan requires 7½″ more room, as shown at C D. *The hand-rail of this case is treated in detail at* PLATE 26.

Fig 7. Plan of the Top Portion of a Staircase Turning One Quarter with Diminished Steps, Curved Risers, Newel and Level Quarter-cylinder, and Platform.—In this plan a small newel is introduced with a connecting level quarter-cylinder ; designed to take the place of plan FIG. 6, where this is preferred. By this plan no wreath or ramp will be required. *A design of newel ; the plan, elevation and management of this case in detail will be found at* PLATE 62.

Fig. 8. Plan for Starting or Landing of a Staircase.—By using a single newel and setting it diagonally, as shown, it will be strong in all of its connections. In some styles of interior finish this position of newel would be desirable.

Fig. 9. Plan of Stairs (Combining Two Platforms with Curved Risers Between) Making a Half-turn.—The management of the hand-rail for this plan of stairs is given in detail at PLATE 41.

Fig. 10. Plan of a Platform Stairs Making a Quarter-turn with a Quarter-cylinder.—Whatever radius is taken for the quarter-cylinder in this description of stairs, in order to make the best form of wreath-piece, from E, the centre of the hand-rail, to risers F and G must be each half a tread. See PLATE 37, FIGS. 5, 6 and 7. Also PLATE 45, FIG. 1.

Fig. 11. Plan of Stairs Turning One Quarter with Winders and a Quarter-cylinder.—In planning this kind of staircase experience has proved that the best shaped hand-rail is produced by bringing the rail at the upper portion, K, straight into the wreath-piece at the end without a ramp, for this reason : one winder at K, above the quarter-cylinder, is all that should be allowed. See PLATE 36.

PLATE NO. 5.

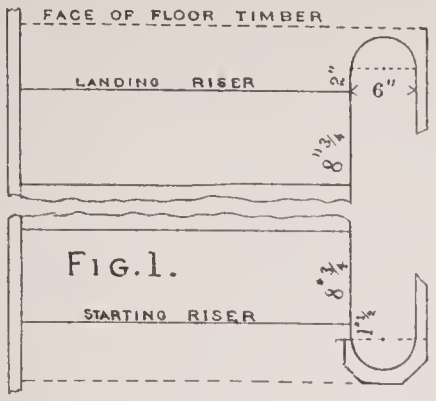


FIG. 1.

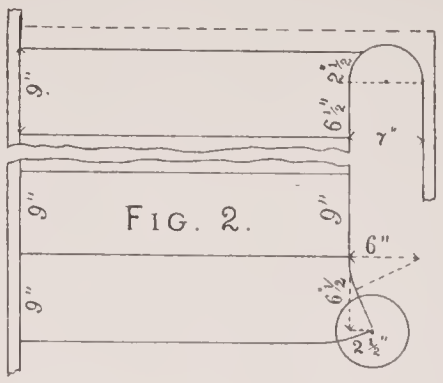


FIG. 2.

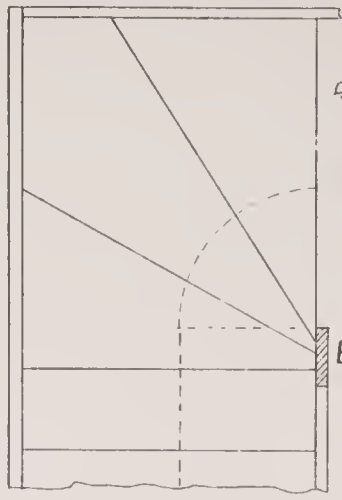


FIG. 3.

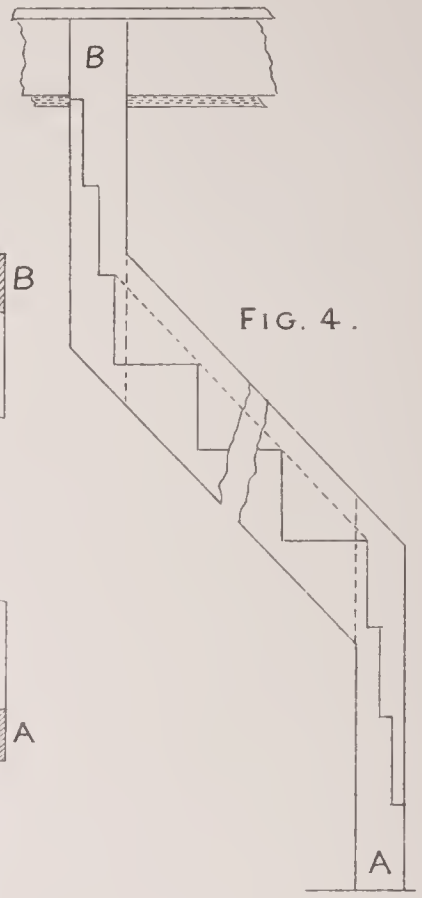


FIG. 4.

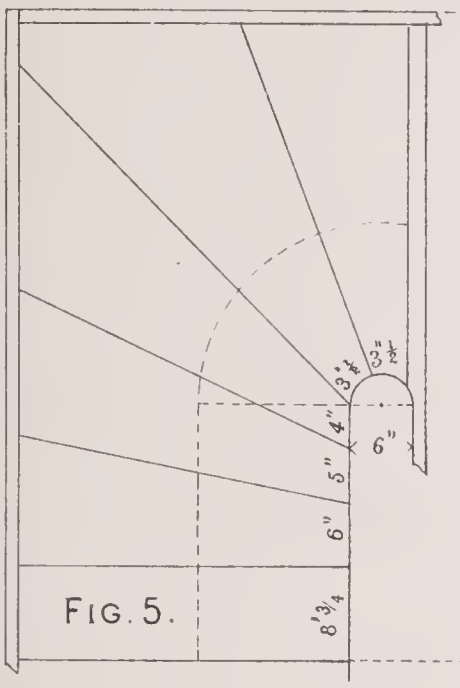


FIG. 5.

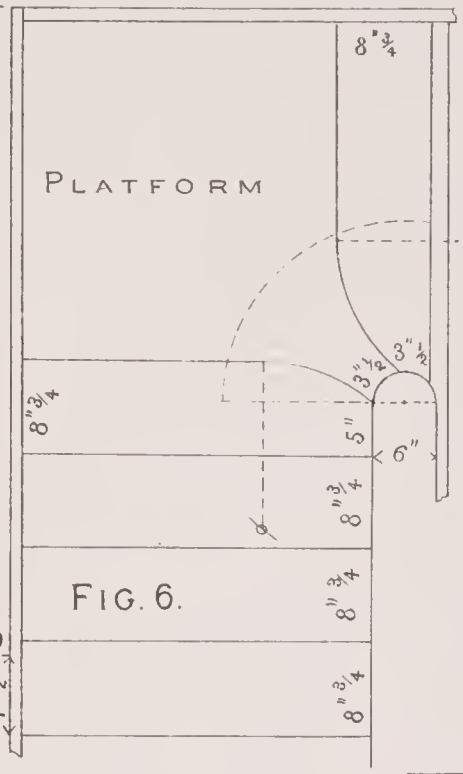
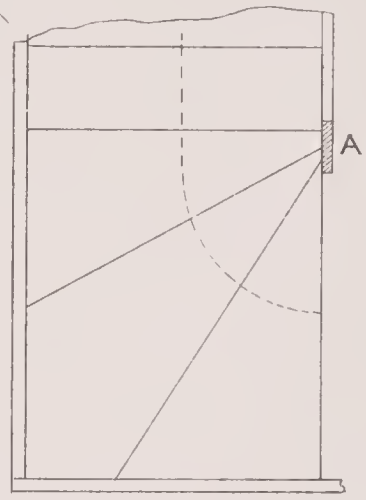


FIG. 6.



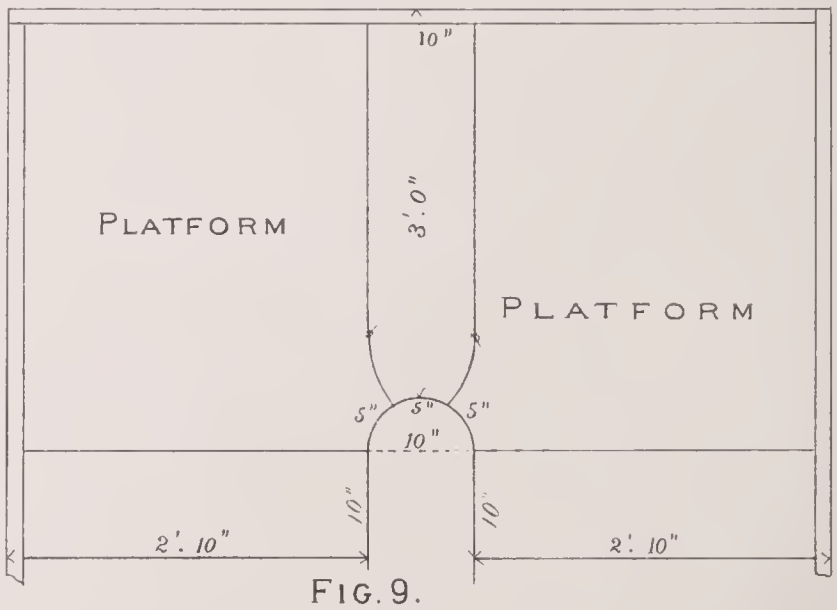


FIG. 9.

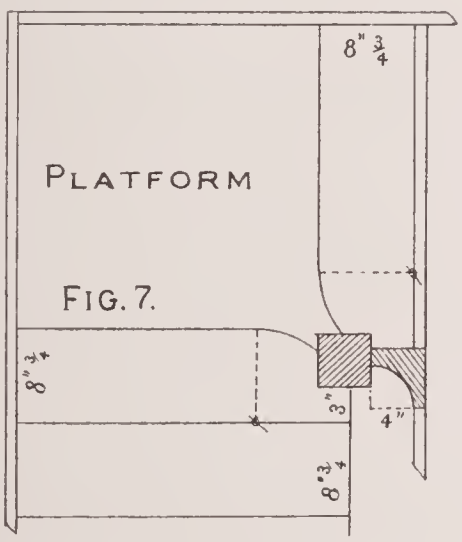


FIG. 7.

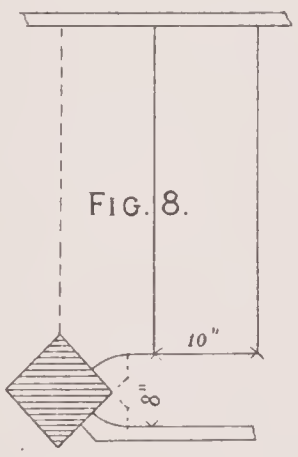


FIG. 8.

SCALE ½ IN = 1 FT.

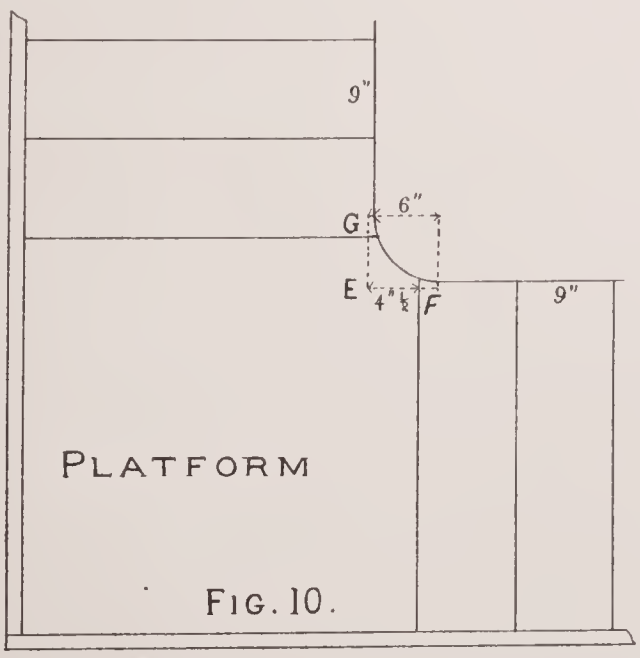


FIG. 10.

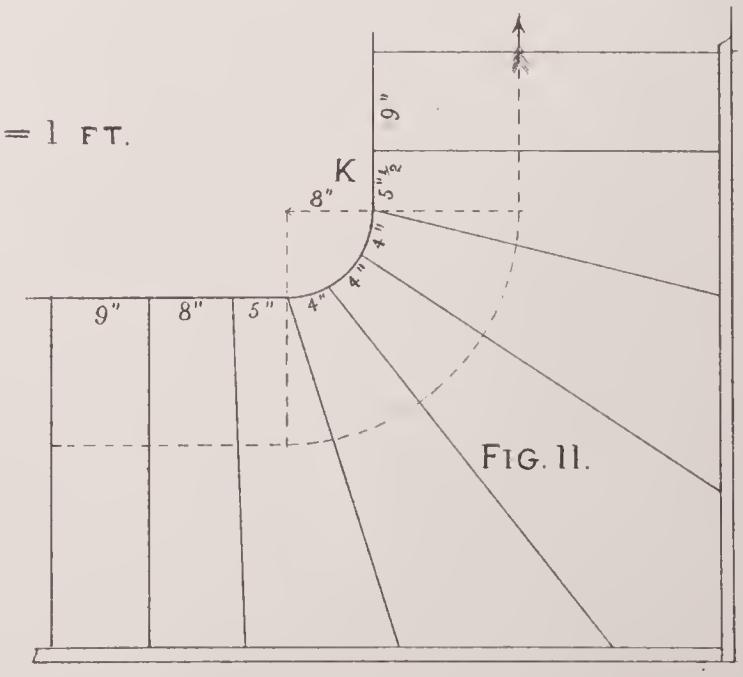


FIG. 11.

PLATE 6.

Fig. 1. Plan of Platform Stairs with the Risers at the Platform Set Into the Cylinder All that can be Profitable.—Placing the risers in the position given on the plan saves 6″ at both the landing and starting flights connected with the platform. The management of the hand-rail is given at PLATE No. 38.

Fig 2. Plan of a Winding Staircase with 10″ Cylinders, Making a Half-turn at Each Cylinder.—The hand-rail for this plan is treated in full detail for the top or landing portion at PLATE No. 28, and for the starting at PLATE No. 29.

Fig. 3. Plan of a Winding Staircase, Two Flights Connecting with a 12″ Cylinder.—The details and treatment of hand-rail are given at PLATE No. 42.

Fig. 4. Plan of Stairs with Newel Set Between Two Quarter-cylinders.—In this case the treatment of hand-rail, if at the top of a flight, will be substantially the same as that given at FIG. 2 of PLATE No. 24, and if at the starting of the flight, FIG. 1 of PLATE No. 24.

Fig. 5. Plan of the Starting of a Staircase.—Where the hall is wide enough and it is desirable to make the flight broad and inviting, the front-string is curved out, embracing four or five treads. This case of hand-rail is treated at PLATE No. 30, FIGS. 1, 2 and 3.

Fig. 6. Plan of Platform Stairs with Low-down Small Corner Newels and Continued Hand-rail.—A design and the management of stairs and hand-rail of this plan are given in detail at PLATE No. 58.

Fig. 7. Plan of Platform Newelled Stairs with Wing-flights.—This staircase, suitable for a very large hall of a public building, is designed to be wainscoted and with half-newels at the walls, as shown, running through and ornamentally finished at the under-side of the stairs. The best effect given to a staircase of this character is by showing the whole open construction of the under-side, tastefully finished, free from plaster or close soffit panelling.

Fig. 8. Plan of Stairs Making a Half-turn, with a Large Cylinder Filled with Treads of Equal Width to those of the Straight Portion of the Flights, and Curving the Ends of the Risers so as to Avoid Winders and Secure an Ample Platform.—Full detail instruction for the management of the hand-rail over this plan is given at PLATE No. 51.

Fig. 9. Plan of Staircase Suitable for Steamboat or Ship, where Every Inch of Space is Valuable.—The requirements of a hand-rail over this plan are treated in detail at PLATE No. 50. See, also, PLATE No. 52.

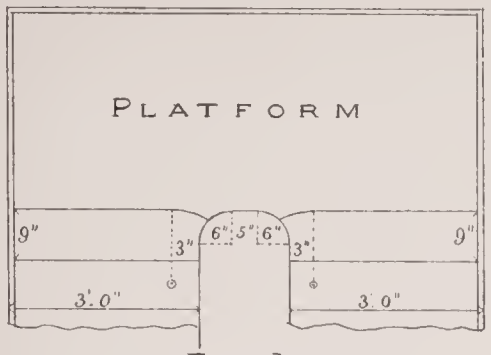


FIG. 1.

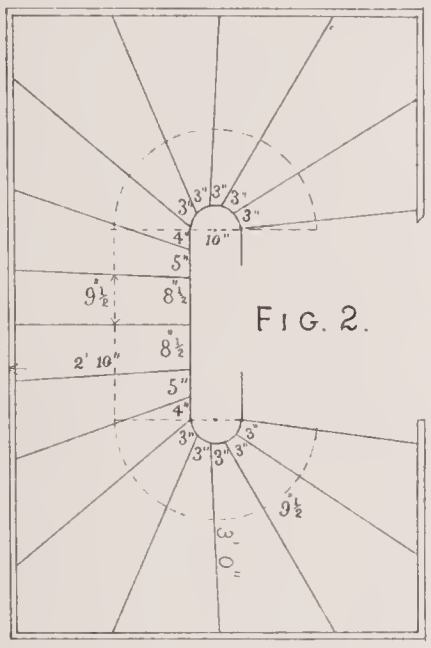


FIG. 2.

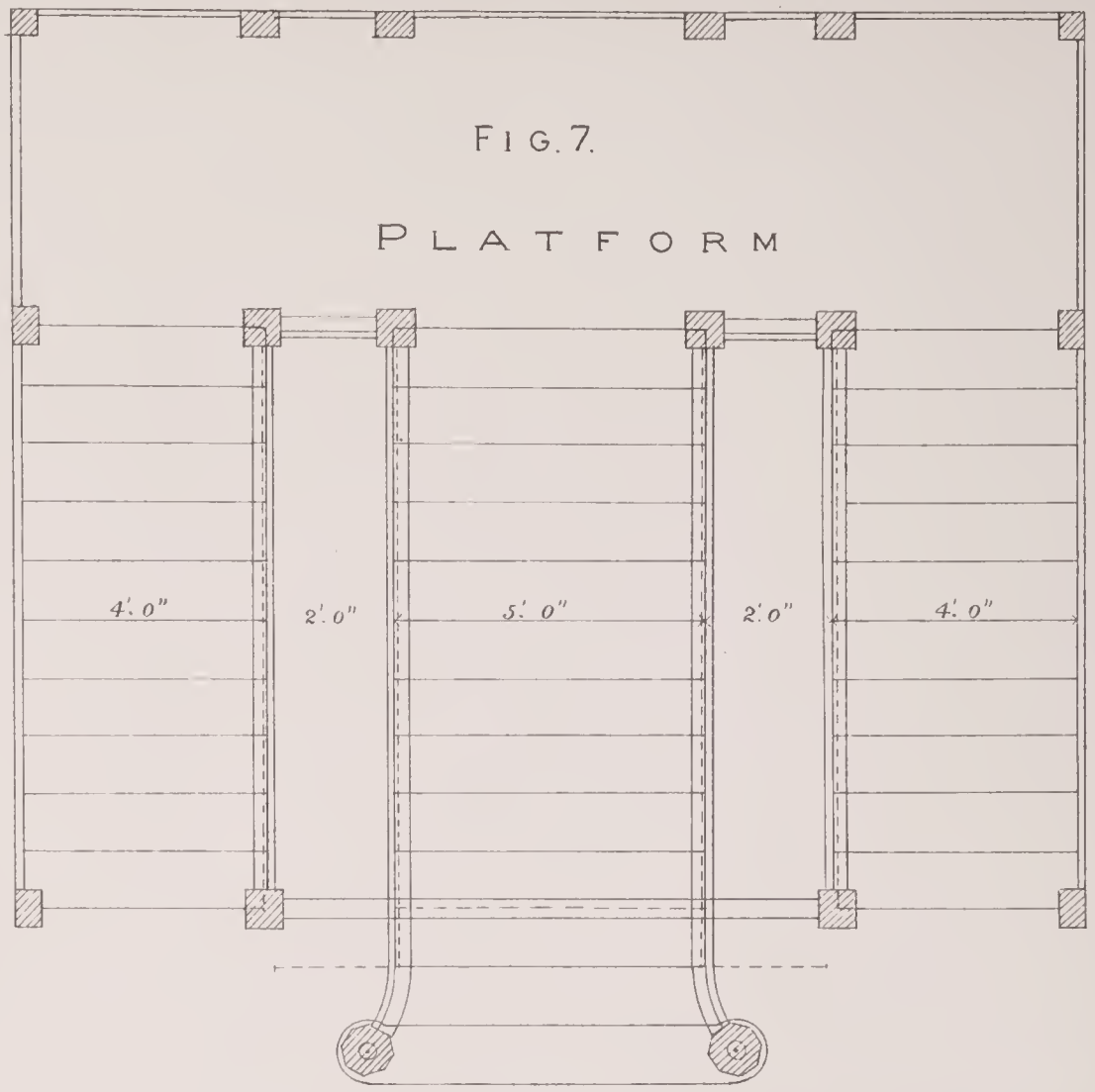


FIG. 7.

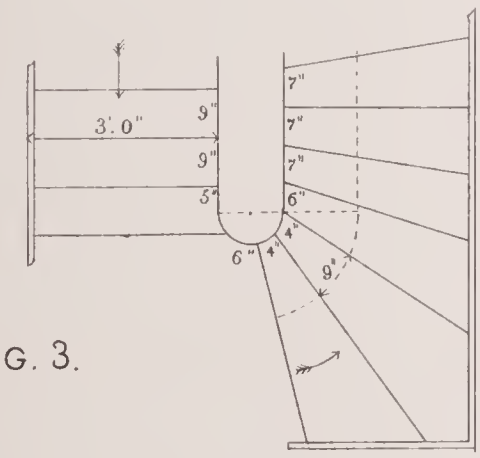
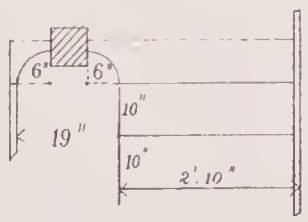


FIG. 3.



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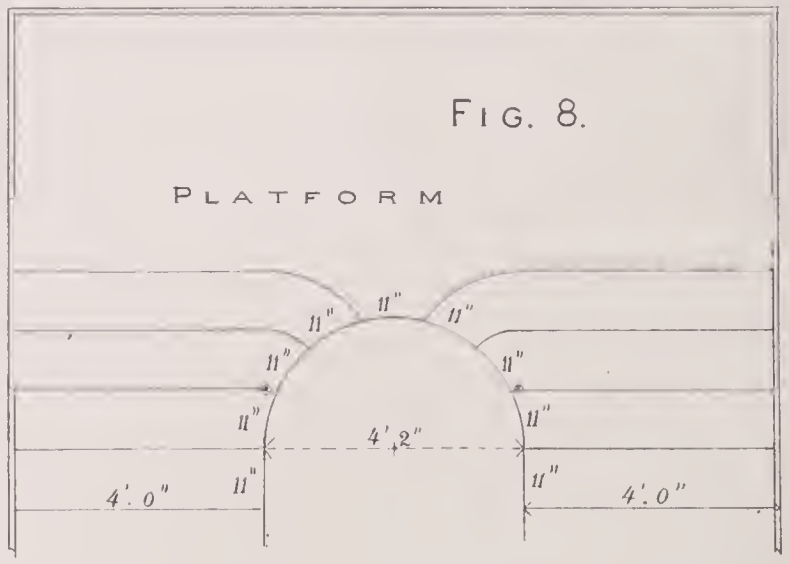
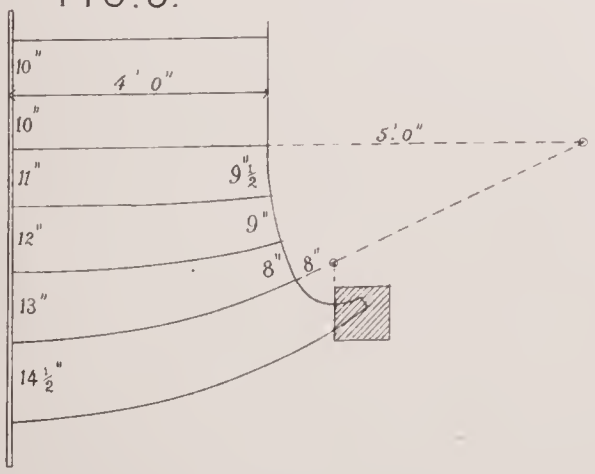


FIG. 8.

FIG. 5.



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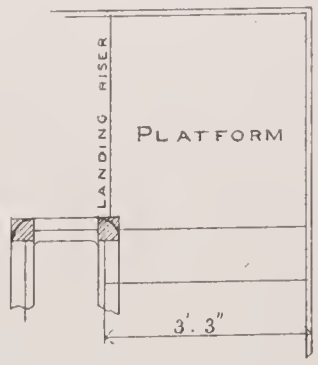

FIG. 6.

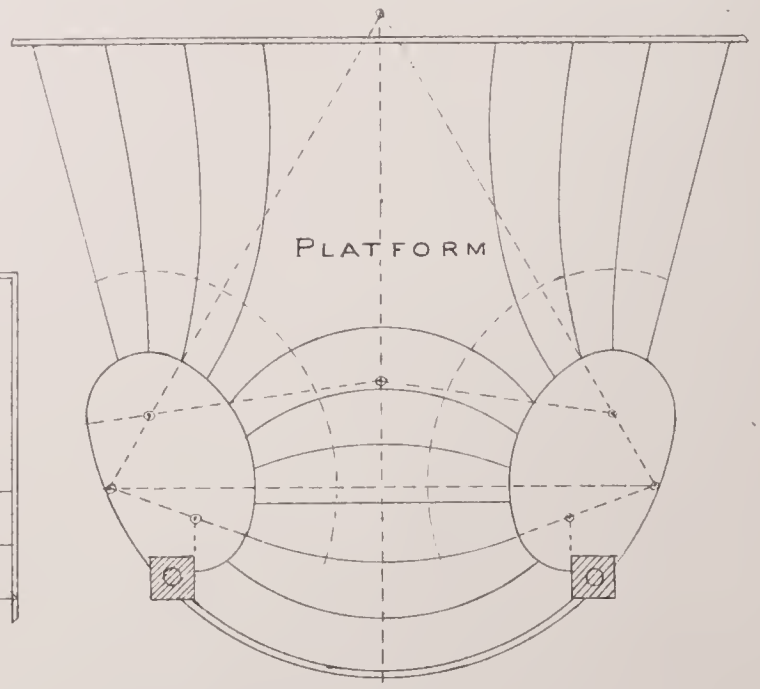

FIG. 9.

PLATE 7.

Fig. 1. Plan of Platform Stairs.—By placing the risers six inches into both cylinders as seen in this plan, that amount of room is saved in each case—a matter of saving that is sometimes of much importance. The treatment of the hand-rail over this plan is given at PLATE No. 40.

Fig. 2. Plan of Double Platform Stairs Made by Introducing a Riser at the Centre of the Cylinder.—The treatment of the hand-rail over this plan is given at PLATE No. 39.

Fig. 3. Plan of Winding Stairs Making a Three-quarter Turn.—The management of the hand-rail over the centre cylinder of this flight is given at PLATE No. 47, and over the starting portion at PLATE No. 48.

Fig. 4. Plan of a Quarter Platform Stairs.—By curving risers in the manner here shown, a good roomy square stepping plan is made of what would otherwise be winders ; somewhat like those of plan at FIG. 6. The details and management of hand-rail over this plan will be found at PLATE No. 46.

Fig. 5. Plan of a Quarter Platform Stairs with Newels Set in the Angles.—The framing of these newels and their connections of hand-rail is given in complete detail at PLATE No. 59.

Fig. 6. Plan of a Quarter-turn Winding Stairs at Starting.—The detailed instruction for the management of hand-rail over this plan is given at PLATE No. 27.

Fig. 7. Plan of the Top Portion of a Quarter-turn Winding Stairs.—The management of hand-rail over a plan similar to this will be found at PLATE No. 26. This plan shows a way of curving the risers so as to save a sometimes much-needed space by lessening the distance from the wall B to the landing riser C.

Fig. 8. Plan of a Quarter Platform Stairs Much the Same as that Given at Fig. 4, Except the Shape of the Cylinder.—The management of hand-rail over this plan is given at PLATE No. 44.

Fig. 9. Plan of a Quarter Platform Stairs with One Tread Placed at the Centre of the Cylinder.—Management and detail of hand-rail over this plan will be found at PLATE No. 43.

Fig. 10. Plan of a Circular Staircase.—The dotted lines show the best method of timbering a staircase of this or similar form. The practical treatment of hand-rail over this plan may be found at PLATE No. 53 ; also at PLATE No. 54 are given full instructions for changing the plan of the first step to the scroll form, the management of that portion of the hand-rail, also the construction of the scroll step.

Fig. 11. Plan of an Elliptic Staircase.—This plan has the treads on the line of wall and front strings graded so that the risers are placed in a direction nearly normal to the curve, keeping an even tread on the line of travel ; which would not be the case if the treads were made equal at the wall-string and at the front-string. The hand-rail over this plan is given in detail at PLATE 55.

Independent or Self-supporting Staircases.—This kind of stairs derives no support from wall or partition ; they are seldom required, but when called for are mostly of a circular plan. An independent straight staircase presents no difficulty ; for all that is required of it is, that it be well secured at the top and bottom, and that the material and construction have ample strength to support the weight it will be liable to carry. Where the plan of a self-supporting staircase is circular with an open well-hole as at FIG. 10,* the timbers at the foot of the stairs R Q P should be bolted to the floor-beams, and bolted at all their connections up to and including the floor-beams at the landing. Jib panels should be put in at the starting of both strings as high up as can be allowed ; or set up a supporting column near the centre of the flight. Or again, if it is convenient, let an iron bolt secured in an adjoining wall project sufficient to support the staircase at about the centre L. With the supports mentioned these stairs may be finished on the under side and made of sufficient strength without timbers by the use of thick laminated† strings, the steps and risers to be well housed into both strings. Iron screws only should be used—no nails.

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* See PLATE 45. † See PLATE 8, FIG. 5.

PLATE No.7.

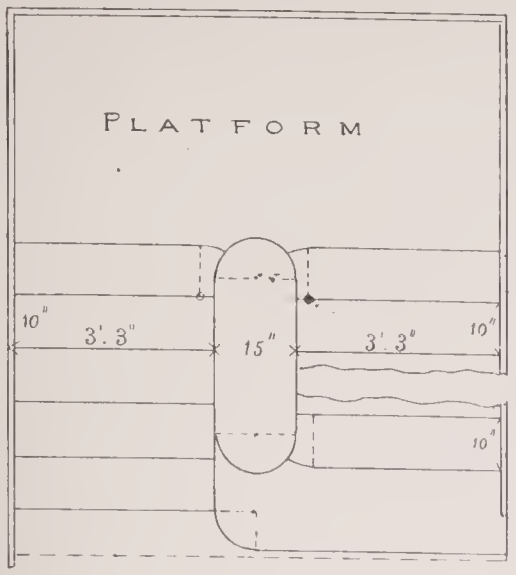


FIG. 1.

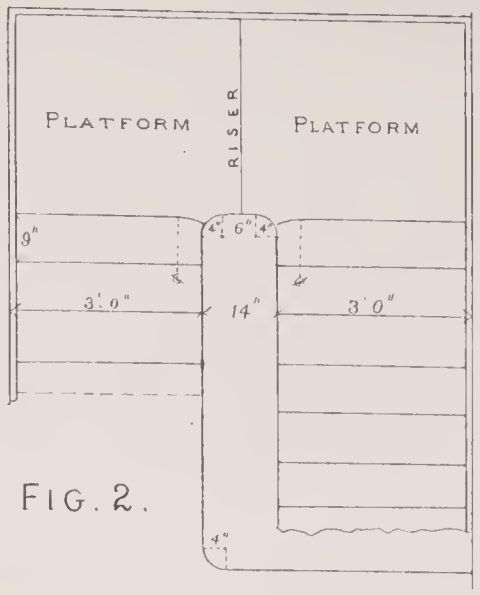


FIG. 2.

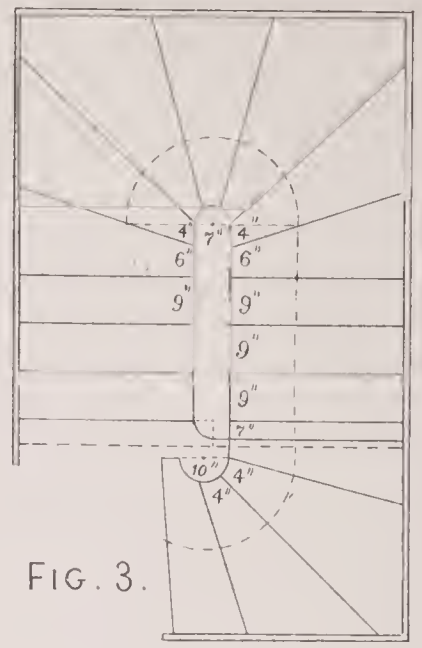


FIG. 3.

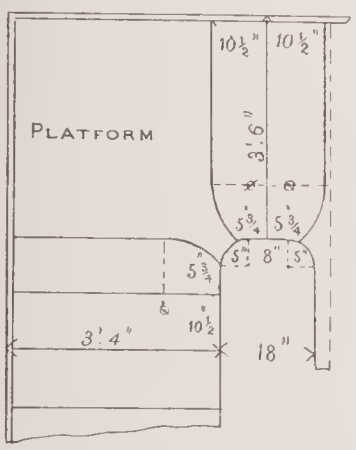


FIG. 4.

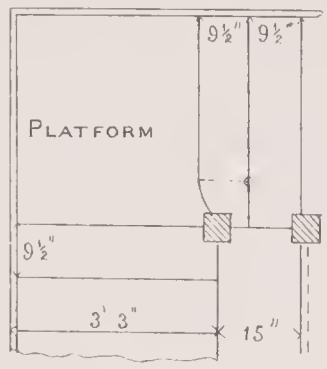


FIG. 5.

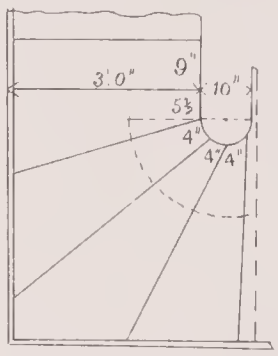


FIG. 6.

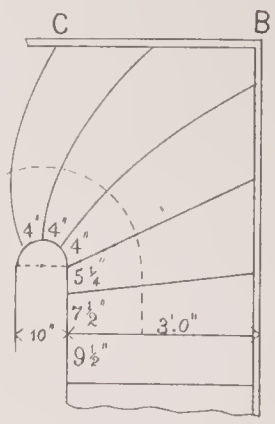


FIG. 7.

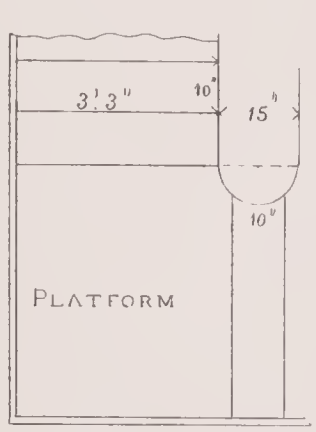


FIG. 9.

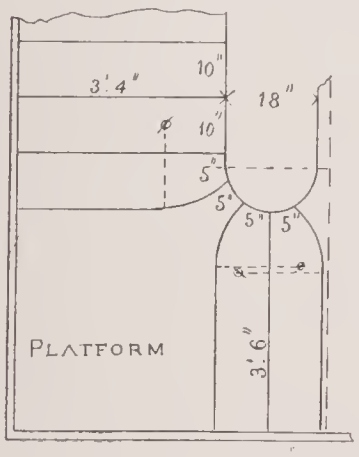


FIG. 8.

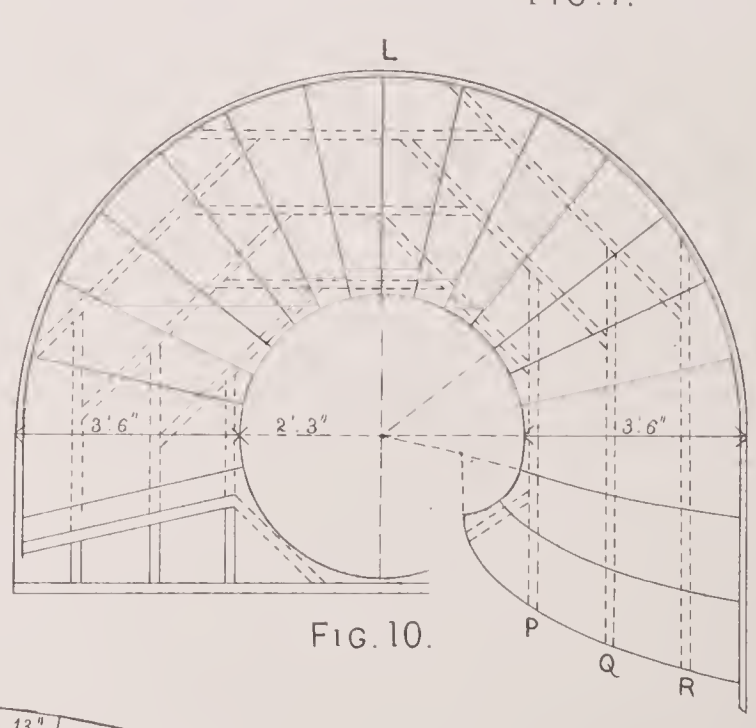


FIG. 10.

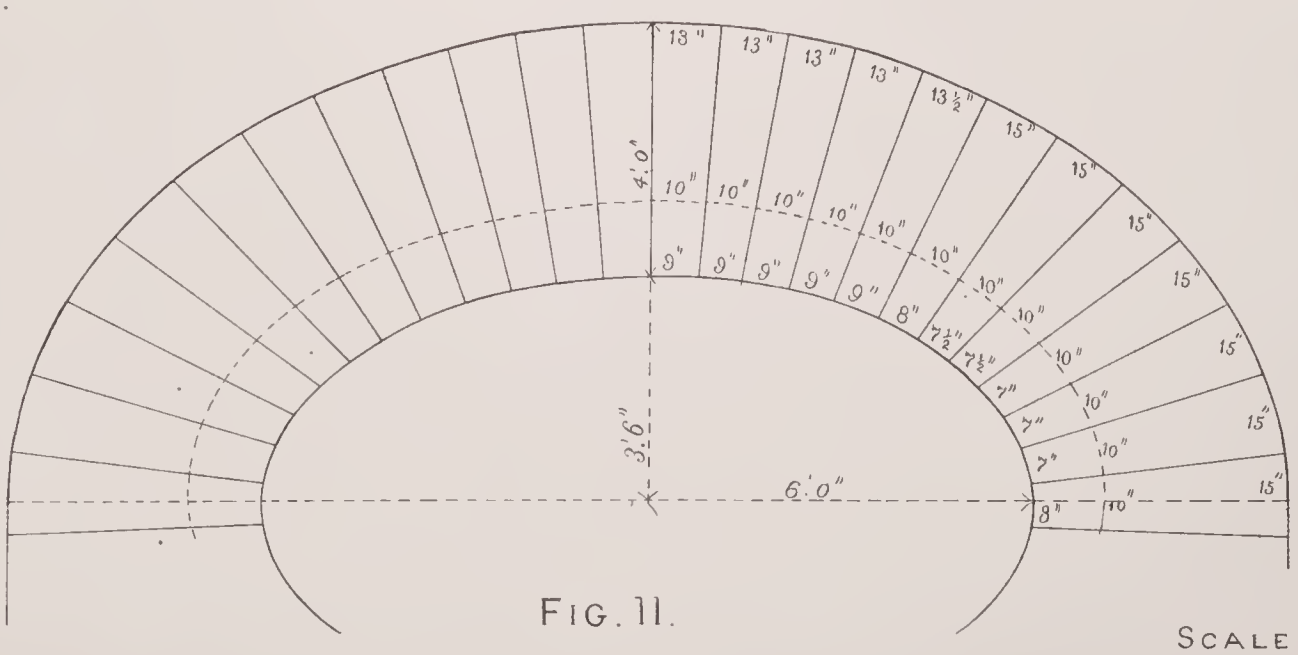


FIG. 11.

SCALE ¼ IN. = 1 FT.

PLATE 8.

Figs. 1 and 2. Bending Wood by Saw-kerfing.—This method of bending is the weakest practised, but owing to the fact that it is thought to be least expensive is frequently adopted. To find the correct distance between saw-kerfs for any required radius of curvature, select a piece of stuff of suitable length and equal to the thickness of the material to be bent, as at FIG. 1. Let A B equal the thickness of stuff, and A C the radius of the required curve; make a saw-kerf at B O, leaving a thin veneer A O uncut, nail the cut piece at S K, and move it from C to D, or just enough to close the saw-kerf at B; then C D being the distance moved will also be the exact space between each saw-kerf. The same gaged thickness of veneer A O must be kept, and the same saw used for the work to be done, as were used in the trial at FIG. 1.

Fig. 2. The Construction of a Circular Form Over Which the Saw-kerfed Material as Above Explained is Shown, Bent in Position.—E F G is the plank rib (made of three pieces) of which two or more are required, according to the work to be done. H J L are the staves which are nailed to the ribs and so complete the circular form. N M is a veneer laid over the form first, upon which is bent and glued the prepared saw-kerfed material P Q R; this must be left on the form until the glue is perfectly dry. The piece of saw-kerfed work P Q R, should be drawn tight to the veneer and the form by means of hand-screws, as given by one example, T U, with curved blocks, V W.

Fig. 3. Bending Wood and Keying.—This form is in plan the same as FIG. 2, except that the rib E F G is not curved at its lower edge;—shaping the lower edge this way is done for the convenient use of hand-screws in the manner shown at FIG. 2.

By this method of bending, the wood is removed from the back of the stuff, as at X X X, etc., leaving the thickness of a veneer at the face; then after bending, the grooves X X X are filled with tightly fitted strips of wood (glued in) called keys, as at S S S, etc. It greatly adds to the strength of this bent keyed work to glue on three strips of veneer,—one at each edge of the keyed stuff, and one in the middle. The glue should be perfectly dry before the work is removed from the form. The spaces between the keys may be determined by the same method as that used to find the spaces between saw-kerfs.

Fig. 4. Bending a Veneer Facing and Filling out the Thickness with Staves.—The wood is removed wholly from the back of the stuff between the points required, leaving a veneer facing which is bent over the form, and then staves, Z Z Z, etc., are fitted and glued on, as shown in this drawing.

Fig. 5. Laminated Work.—Bending several thicknesses of veneer together is defined as laminated work. The whole of the veneers required should be heated and bent over the form together and secured in place; then releasing and applying glue to one-half, put it back in position again, and proceed with the other half in the same way, pressing and binding solidly the whole together and to the surface of the form.

To ascertain what thickness of white pine will bear bending without injuring its elasticity, multiply the radius of curvature in feet by the decimal .05 and the product will be the thickness in inches:—For example, multiply a four feet radius of curvature by the decimal given,—4′.0″ × .05=.20, equal to two tenths or one-fifth of an inch thickness, that would bend without fracture.

Fig. 6. Bending Stair-strings.—This drawing shows the construction of an ordinary quarter circle form with the correct position of a stair-string bent over it; the ribs of this form are quarter circles and are set parallel to each other and at right angles to the chord line R P.

Figs. 7 and 8. Construction of a Form for Bending Quarter Circle Stair-strings, the Ribs to be Set on an Angle Parallel to the Inclination of Such Strings.—There are two advantages claimed for forms built in this way; one is, a saving of stuff; the other, that the form occupies less room.

Fig. 8.—Plan of a quarter turn of winders with a circular wall-string. D E, the circular wall-string as laid out from the plan A B. At FIG. 7, L M and F H is the position of the ribs parallel to D E the inclination of the circular string; F G equals C A of FIG. 8—less the thickness of stave—and is the semi-minor axis, and F H becomes the semi-major axis of an ellipse; as the shape of the rib when placed on the oblique line F H, becomes a quarter ellipse. The ribs have to be beveled on the edge to range with the lines L F and M H, as shown.

Figs. 9 and 10. Soffit Mouldings.—These mouldings, placed at the lower edge of stair-strings, have to be carried around cylinders, and this work can be done in different ways. A cylinder may be made of sufficient length and reinforced—filled out by gluing on pieces, as at O R S, FIG. 10—then the moulding is worked out solidly in connection with the cylinder. Another way is to shape up the lower edge of the cylinder filled out as at O R S, then fit and shape two or more solid pieces—depending on the size of cylinder—of a thickness and width sufficient to carry out a moulding similar to N P, FIG. 9.

Figs. 11 and 12. To Find the Lengths of Cylinder Staves that Include Winder-treads.—Set up an elevation of treads and risers sufficient to get the shape of cylinder in its connections with the straight string and facia, as here shown and as before fully explained at FIG. 3, PLATE NO. 4. Divide the opening out of the cylinder V W, into three equal parts, V Z, Z X and X W; parallel to the risers draw the lines Z L, X S and W T; then the length of each stave and its position is given at M B, L F and S X. The construction of this cylinder and the winder-treads contained in it are given at FIG. 11. The manner of splicing and connecting a staved cylinder with a straight string is given at PLATE NO. 3, FIG. 3.

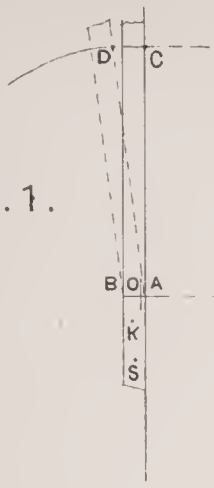


FIG. 1.

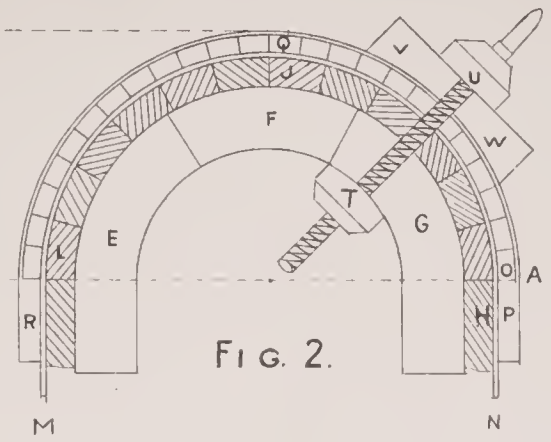


FIG. 2.

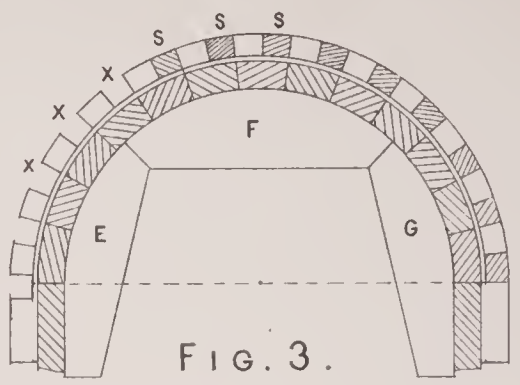


FIG. 3.

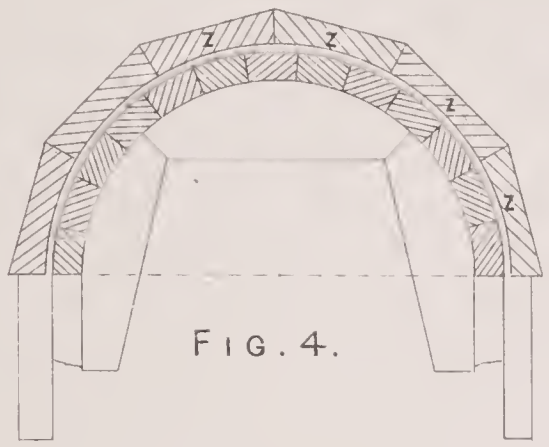


FIG. 4.

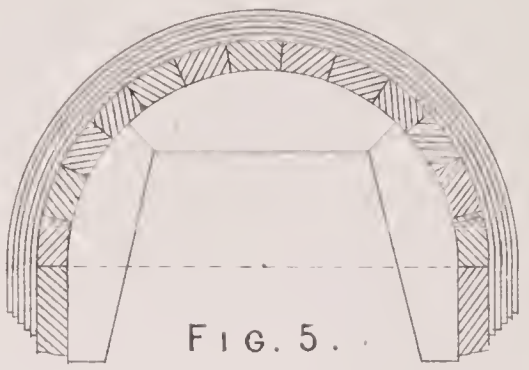


FIG. 5.

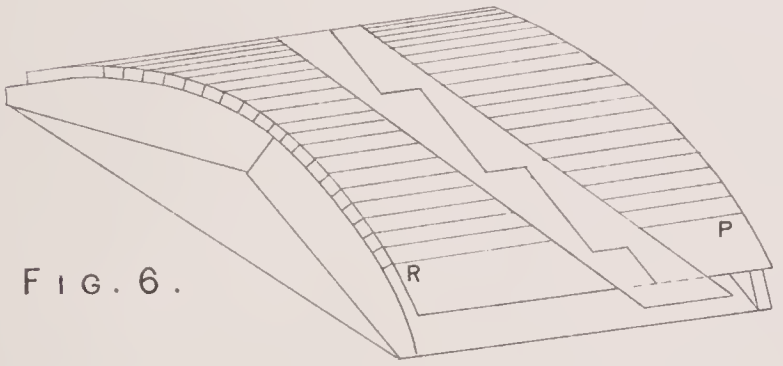


FIG. 6.

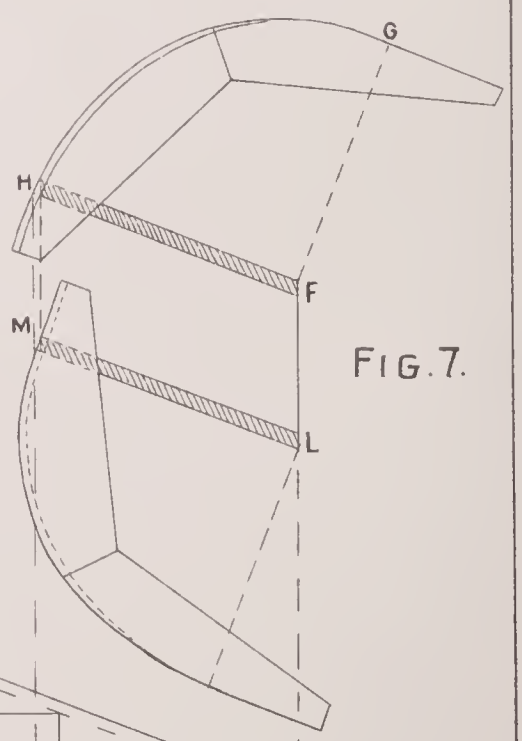


FIG. 7.

FIG. 11.

SCALE ½ IN. = 1 FT.

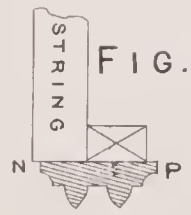
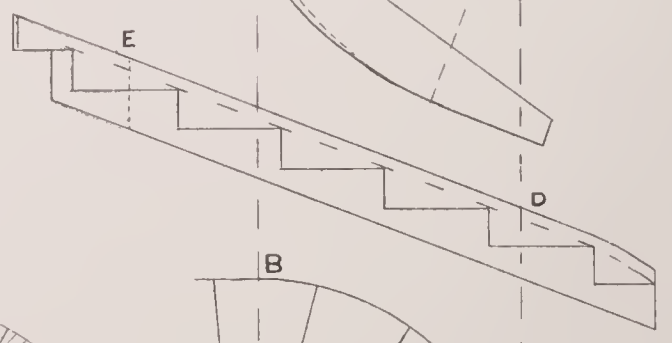


FIG. 9.



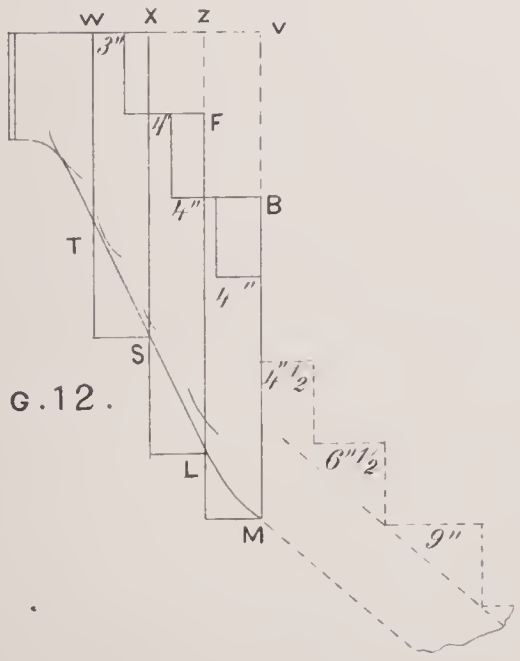


FIG. 12.

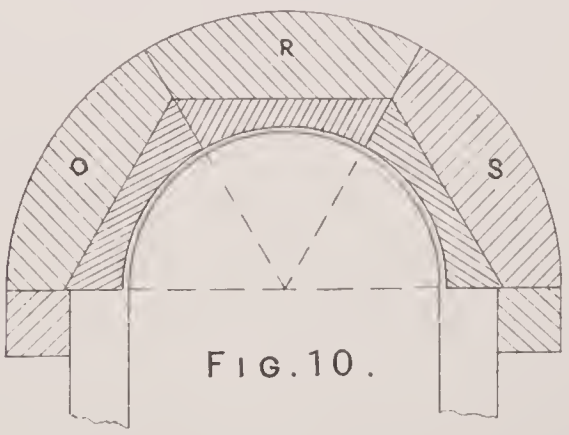


FIG. 10.

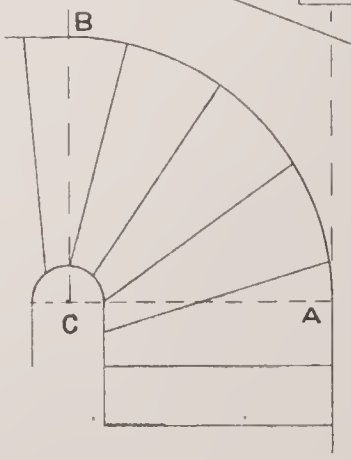


FIG. 8.

PLATE 9.

The method of one-plane projection is where the projection on the horizontal plane is alone required. *Merely illustrative examples are here given of the practical application of the one-plane method in drawing face-moulds for hand-railing.*

Fig. 1. To Find the Angle of Tangents and Centre Line Over a Plan of a Quarter-circle, where the Tangents are required to have a Common Inclination.—Let A V Y be the plan, with the tangents A U and U Y; let A W U and U T Y be the common angles of inclination; connect U X, the level line common to both planes; through Y and A draw the line R S indefinitely; on U as centre with U T as radius describe the arc T S and the arc at R; connect R U and S U; bend a flexible strip and mark a curve through the points R V S: then R U S will be the length and angle of the tangents, and R V S the curve-line over the plan A V Y. *To find the angle with which to square the wreath-piece at both joints*:—On U as centre describe the arc Z B; connect B A: then the bevel at B will contain the angle sought.

Fig. 2. To Find the Angle of Tangents and the Centre Line Over a Plan of a Quarter-circle when the Tangents have Different Inclinations.—Let the plan be A F M, with the tangents A B and B M; let the two inclinations be A G B and B C M. *To find the level line common to both planes*: Make C Q equal to B G; parallel to M B draw Q O; parallel to M C draw O N; connect N K: then N K is the line sought. Parallel to N K draw B I; at right angles to N K draw M D and A E; on B as centre with B C as radius describe the arc C D; again, on B as centre with A G as radius describe an arc at E; connect E B and B D; bend a flexible strip and mark a curve through E F D; connect E D: then E B D will be the lengths and angle of tangents, and E F D the curve-line over the plan A F M. *To find the angle with which to square the wreath-piece at joint* D: Continue B M to L; make M L equal Q P; connect L K: then the bevel at L contains the angle required. *To find the angle with which to square the wreath-piece at the joint* E: Draw I J parallel to M K; make I J equal B H; connect J A: then the bevel at J contains the angle sought.

Fig. 3. Plan of Hand-rail a Quarter-circle, with the Tangents to the Centre Line A F and F D, the Tangents to have Common Angles of Inclination.—Let A G F and F E D be the angles of a common inclination; connect F X; from K, parallel to F X, draw K L; from J, parallel to D E, draw J M; through A and D draw A C; on F as centre with F E as radius describe the arc E C. *To find the angle with which to square the wreath-piece at both joints*: Make F H equal F I; connect H A: then the bevel at H contains the angle sought.

Fig. 4. To Draw the Face-mould from Plan Fig. 3.—Make B C, B C equal B C of Fig. 3; make B F at right angles to B C and equal to B F of Fig. 3; connect F C and F C; make F M and F M each equal F M of Fig. 3; through M and M, parallel to B F, draw K L and K L; make M L, M K, at each side of the centre equal J L and J K of Fig. 3; make B N O equal the same at Fig. 3; through C and C draw K P and K Q; make C P equal C K, and C Q equal C K; let C S equal straight wood, as required; parallel to C S draw K T and Q R; parallel to M C draw K U; make the joints at right angles to the tangents; through Q L O L P of the convex and K N K of the concave trace the curved edges of the face-mould.

Fig. 5. Plan of Hand-rail a Quarter-circle, with Tangents to the Centre Line, Q Z and Z X, the Tangents to have Different Inclinations.—Let Q M Z and Z G X be the required inclinations of the tangents. *To find a level line common to both planes*: Make G H equal Z M; draw H E parallel to Z X, and E V parallel to G X; connect T P: then T P is the line sought. Parallel to T P draw I J, Z A and C D; parallel to Z M draw R L; parallel to X G draw Y F; at right angles to P T draw X W and Q O; on Z as centre with Z G as radius describe the arc G W; again, on Z as centre with Q M as radius describe an arc at O; connect O W. *To find the angle with which to square the wreath-piece at joint* O: Draw A B parallel to Q Z; make A B equal Z N; connect B Q: then the bevel at B contains the angle required. *To find the angle with which to square the wreath-piece at joint* W: Prolong Z X to K; make Z K equal H 2; connect K P: then the bevel at K will be the angle sought.

Fig. 6. Face-mould from Plan Fig. 3.—Make O U W equal the same at Fig. 5; on U as centre with U Z of Fig. 5 as radius describe an arc at M; on O as centre with Q M of Fig. 5 as radius intersect the arc at M; connect O M, M W and M U; make M E F equal Z E F of Fig. 5; make M L equal M L of Fig. 5; parallel to M U draw I F J, 3 E V and C L D; make L D, L C and M S 4 equal R D, R C and Z S 4 of Fig. 5; make E V, E 3 and F J, F I equal T V, T 3, Y J and Y I of Fig. 5; through W draw I P; make W P equal I W; through O draw C R; make O R equal O C; make O T straight wood, as required; parallel to O T draw C N and R Q; make the joints at right angles to the tangent; parallel to W M draw I Z; through R D S V J P of the convex and C 4 3 I of the concave trace the curved edges of the face-mould.

Face-moulds, their Number and Character.

1. Plan: Quarter-circle—one tangent inclined, the other horizontal.
2. " " tangents " alike.
3. " " " " differently.
4. " Less than a quarter-circle—one tangent inclined, the other horizontal.
5. " More than a quarter-circle—one tangent inclined, the other horizontal.
6. Plan: Less than a quarter-circle—tangents inclined alike.
7. " " " " " differently inclined.
8. " Elliptic or eccentric—tangents inclined alike.
9. " " " " differently.
10. " Greater than a quarter-circle—tangents inclined alike.
11. " " " " " differently.

It is believed that the above list of eleven face-moulds comprises all that are required in hand-railing. There are two face-moulds, however, that are given in this work not on the list, one at Plate No. 34 and another at Plate No. 35, each of which include the whole cylinder—a semicircle. These may be called compound face-moulds, for the first is explained at Plate No. 14 and used at Plate No. 34, with a portion of the curve more than the face-mould proper, and worked with the wreath, thereby completing the semicircle in one wreath-piece; the other is double the face-mould given at Plate No. 10, the two used as one and worked as directed at Plate No. 35, completing the semicircle in one wreath-piece.

Note.—These face-moulds are all given in the above order, beginning at Plate No. 10.

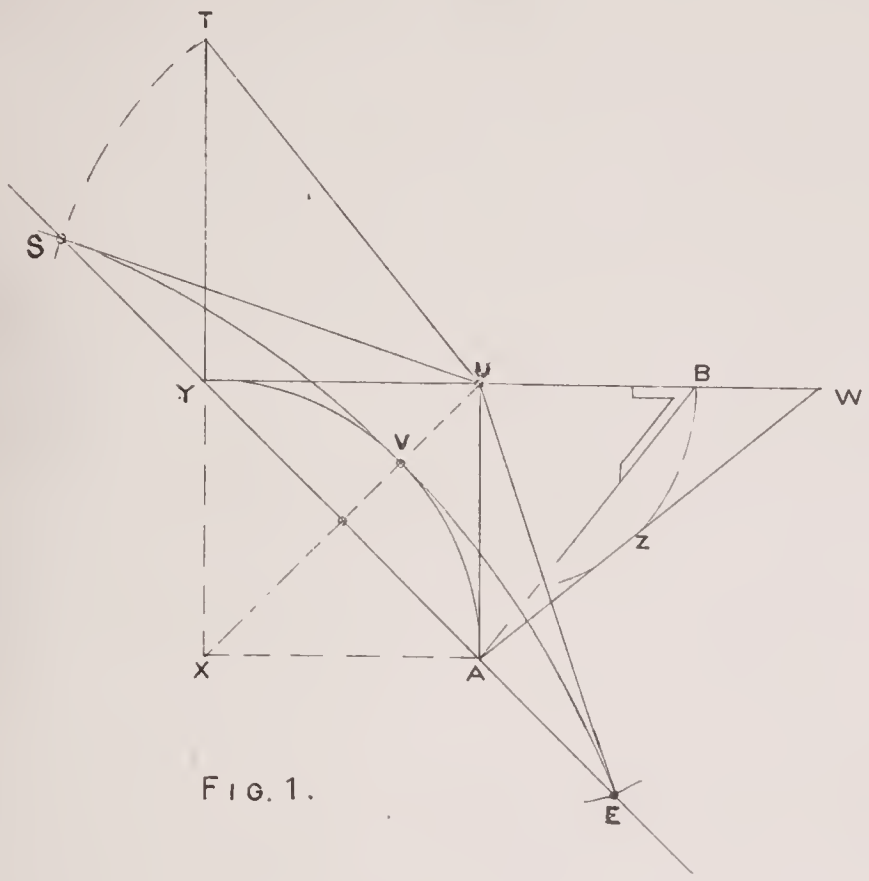


FIG. 1.

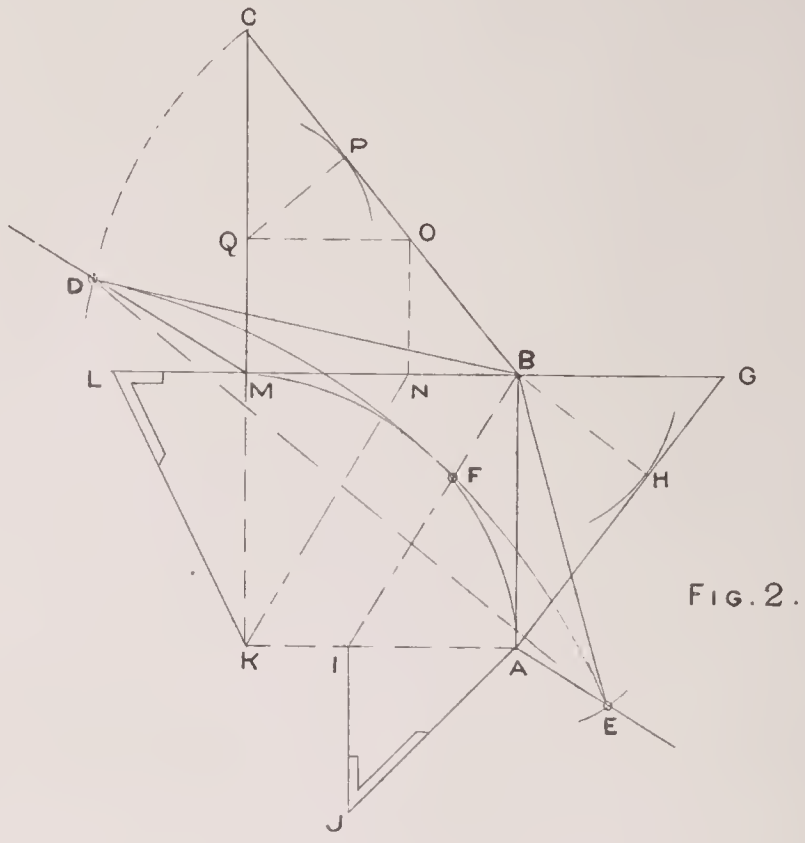


FIG. 2.

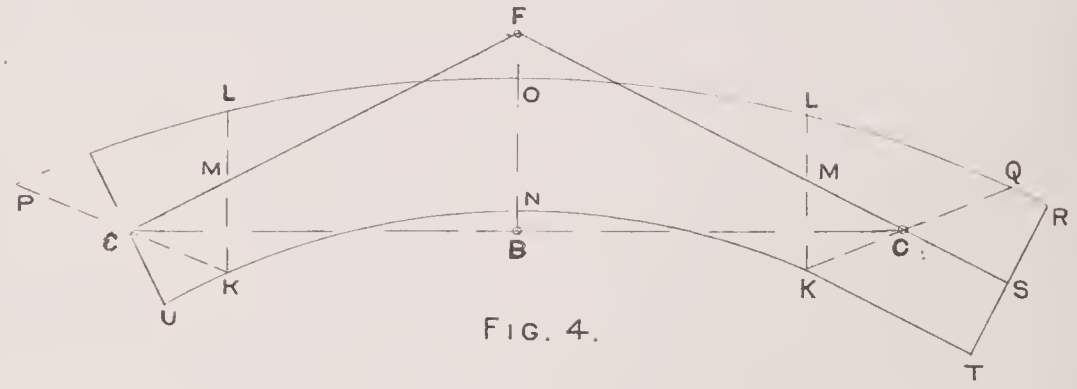


FIG. 4.

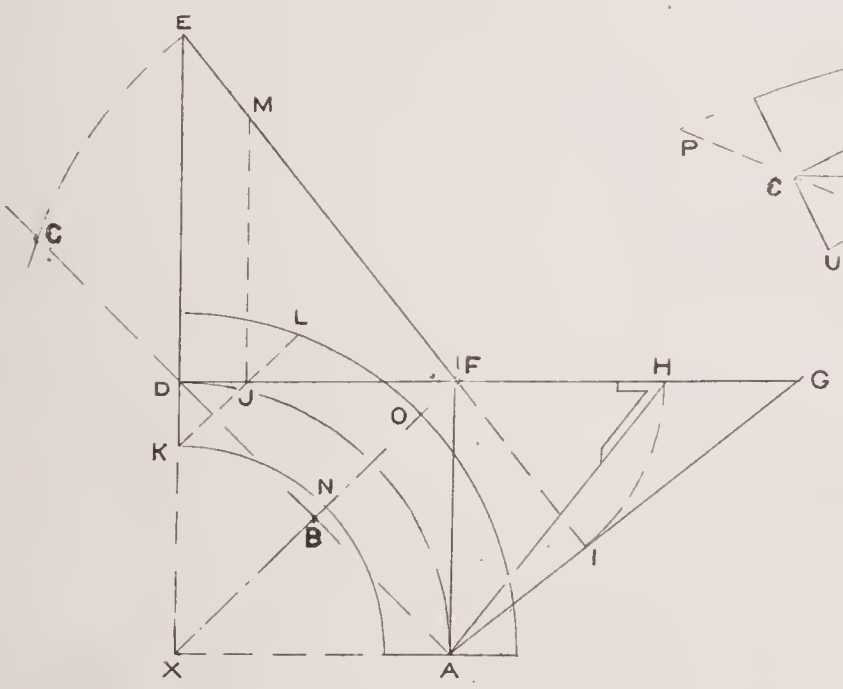


FIG. 3.

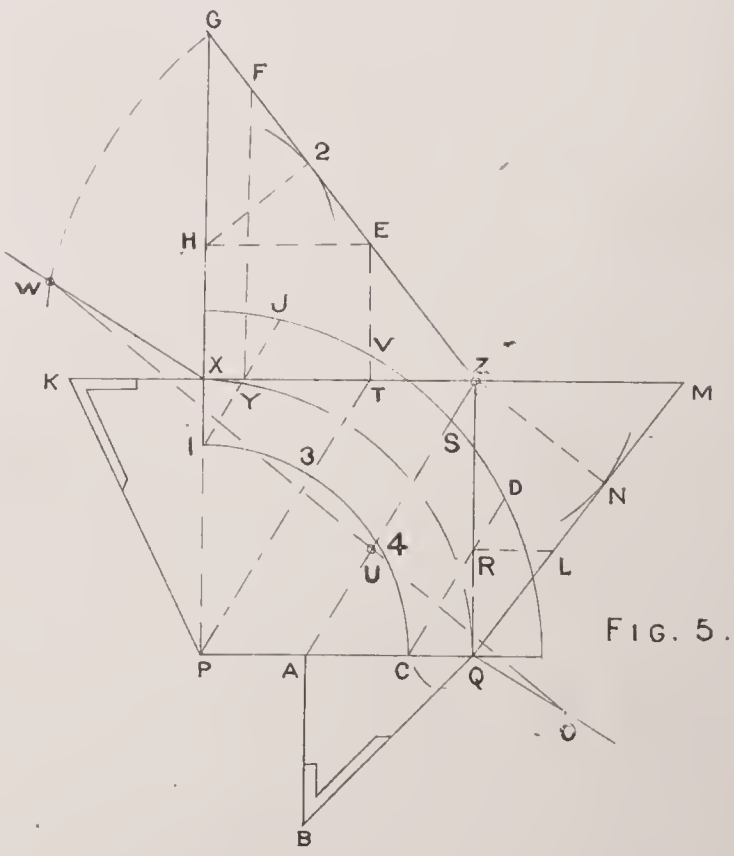


FIG. 5.

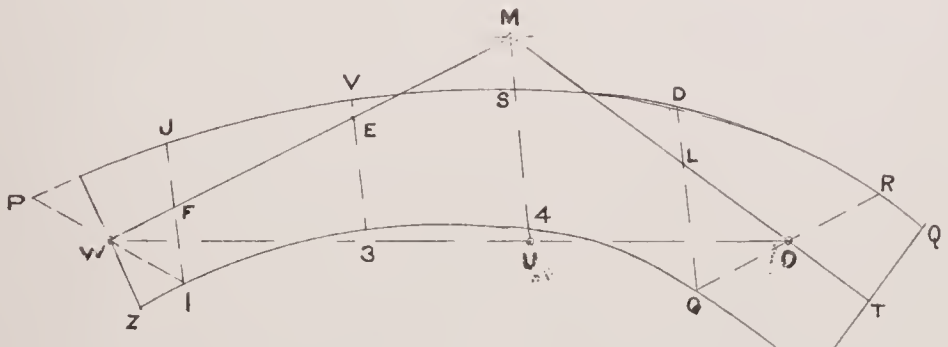


FIG. 6.

PLATE 10.

This plate is the first of ten prepared for the purpose of giving instruction in a simple and practical way in the scientific requirements of hand-railing, based on a few and easily-applied laws of geometry.

The object and use of the solids—rectangular, acute and obtuse angled prisms—introduced in these elementary plates, may be summed up briefly : as a convenient and direct means of imparting to workmen this branch of geometrical knowledge ; as demonstrating the importance and use of tangents as applied to hand-railing, for two of the vertical sides of every prism given are tangent to a curve described on the base, and tangent to its trace on the cutting plane. The upper end of each prism is cut inclined on one or two angles of inclination in the same plane, and shows the actual relation of the inclined or cutting plane to the horizontal plane or base ;* or, as may be again stated, exhibits in every case the exact relation of a plan as given on the base and a section of the plan traced vertically on the inclined plane. The cutting plane, as produced on one end of these solids, is in each particular case the position of the plane or surface of plank out of which the wreath-piece has to be worked. The face-mould and its tangents are found on this plane ; therefore the face-mould when applied to the plank gives the shape of the convex and concave sides of the wreath-piece, which must hang vertically—or plumb—over the curved plan beneath. The paper representations of solids† are to be preferred because they can be more easily and conveniently made than wood solids ; and in making them they afford instruction in detail that wood solids do not, because in the formation of solids with paper the surfaces, angles and curves all have to be found in their proper relation on one plane, which it will be seen is the practice and knowledge required for drawing face-moulds correctly.

Fig. 1. Represents a Solid Block or Prism Standing Vertically on a Square Base, A B D C, **the Upper End Cut on an Inclined Plane,** A E F C, **forming Oblique Angles with the Sides** A C **and** B D, **and at Right Angles to the Sides** A B E **and** C D F.—Upon the base is described a quarter-circle, B C, tangent to the sides of the solid C D and D B. As E F is parallel to the square base C A B D, it is therefore a level line on the cutting plane C A E F ; and as B D at the base and E F on the cutting plane are level lines, any measurement taken on level lines at the base, as G H, J K and L M, and carried vertically to the cutting plane, as G R, J P and L N, and then parallel to the level line F E set off as at R S, P Q and N O, will give trace points of a curve on the cutting plane perpendicularly over the plan curve at the base.

Fig. 2. Construction of a Paper Representation of a Solid with its Angles, Surfaces and Curved Lines as Given in Perspective and Described at Fig. 1.—Let A B C D be the square base of the solid, and D F C the angle of inclination over the base C D and A B ; make D V, B W and B E each equal D F and at right angles to the sides of the base ; connect E A, B W, W V and V D ; continue D C to T, and B A to U ; let A U equal A E, and C T equal C F ; connect U T. On A as centre describe the quarter-circle B C, tangent to the sides of the base C D and B D ; through any points on the curve H K M, parallel to the level line B D, draw the lines H G X, K J X and M L X ; make C N P R T equal C X X X F ; draw R S, P Q and N O parallel to U T, and equal to L M, J K and G H : then U S Q O C will be the trace of a curve on the cutting plane lying perpendicularly over the plan curve B H K M C. With a sharp-pointed instrument scratch the lines A B, B D, D C and C A ; cut out the remainder of the figure and touch the adjoining edges with a little glue or thick mucilage and bring them together, leaving all lines on the outside, so that their connections may be seen and understood.

Fig. 3. Plan of Hand-rail a Quarter-circle, with One Tangent to be Inclined, the Other Level.—B D and D C are the plan tangents to the centre line B C ; let D F C be the angle of inclination over the plan tangent C D ; the tangent D B to remain level ; parallel to D B draw E Q O, J M O and R S O. The bevel at F contains the angle with which to square the wreath-piece at joint B ; joint C is squared from the face of the plank.

Fig. 4. Face-mould from Plan Fig. 3.—Make B F and F C at right angles ; let F C equal F C of Fig. 3, and F B equal D B of Fig. 3 ; through B draw V E at right angles to B F ; make B V equal B E ; make F O O O equal F O O O of Fig. 3 ; parallel to F B draw O Z, O Y E, O X W and C G H ; make F I equal D U of Fig. 3 ; make O Z equal T S of Fig. 3 ; make O Y equal P N and P E of Fig. 3, and O X and O W equal L K and L J of Fig. 3, and C G and C H equal C G and C H of Fig. 3 ; through the points V I Z Y X G of the convex and E W H of the concave trace the curved edges of the face-mould.

Fig. 5. Parallel Pattern for Round Rail, or to be Used Instead of the Face-mould for Marking the Wreath-piece on the Rough Plank.—The measurements are taken from the plan at Fig. 3, as indicated by the corresponding letters. Through the central points C M Q R B describe circles of any radius required ; touching these circles on the convex and concave bend a flexible strip of wood and mark the curved edges of the pattern.

For ordinary-sized hand-rail wreath-pieces may be worked out of stuff as thick as the width of rail, and a parallel pattern about ¾″ wider than the required width of rail. See Plate No. 56, Figs. 6 and 7.

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* It should be understood that the bases of all these solids are cut square, or at right angles to their length ; also at the upper end two adjoining sides of any solid may be cut on two different angles of inclination, or a common angle of inclination ; or one side may be cut at right angles to its length and the adjoining side at any inclined angle ; but in every case the opposite sides must be cut paralliel. † Drawing-paper, such as Whatman's, is best to make paper representations of solids—pasteboard is too thick and clumsy.

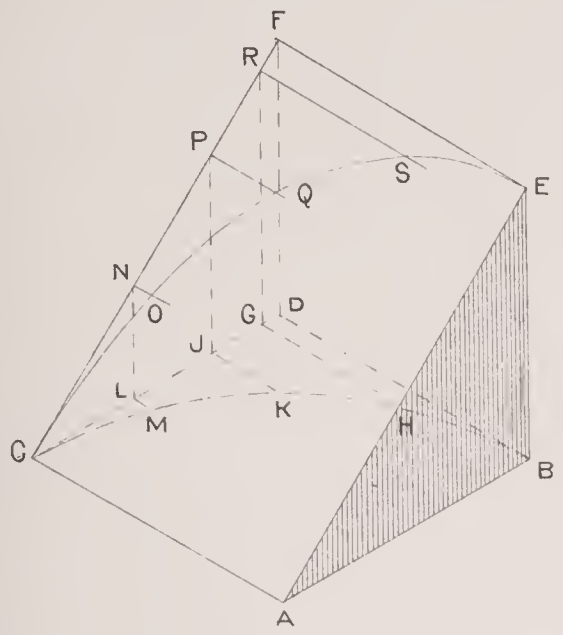


FIG. 1.

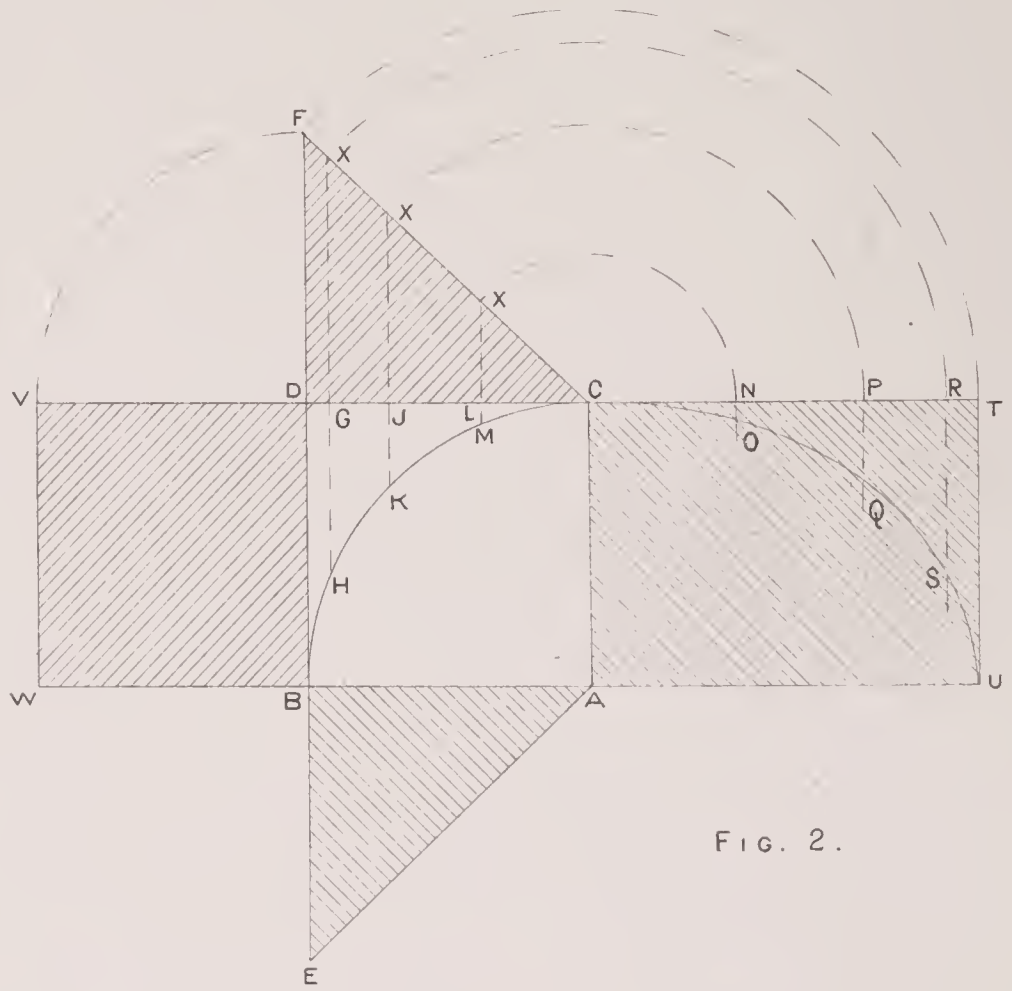


FIG. 2.

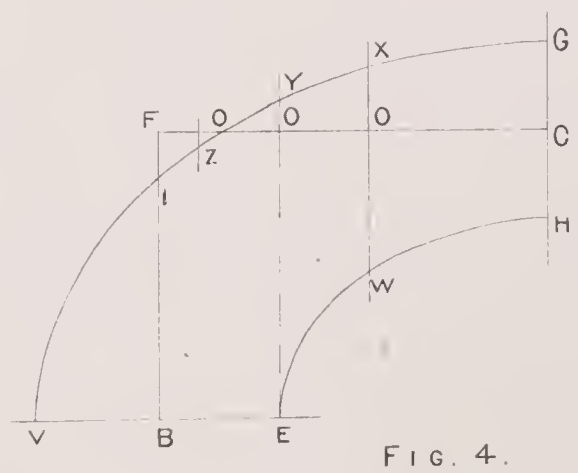


FIG. 4.

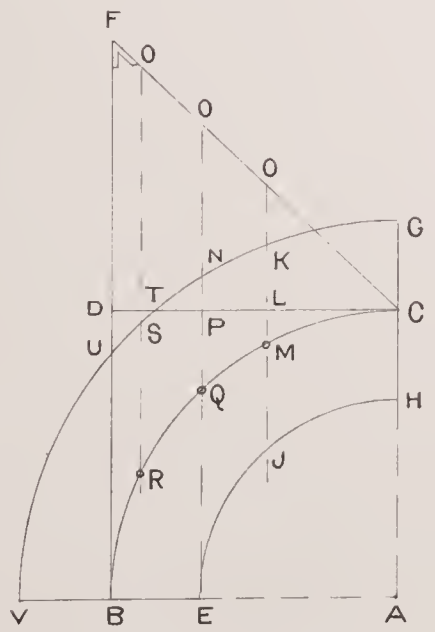


FIG. 3.

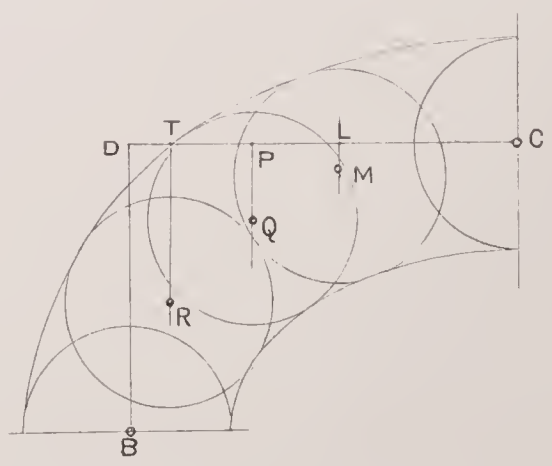


FIG. 5.

PLATE 11.

Fig. 1. Represents a Solid Block or Prism Standing Vertically on a Square Base, Z X W Y, the Upper End Cut on the Side Z X on the Angle of Inclination, X V Z, and on the Side X W on the Same Angle, K U V.—On the horizontal plane or base, Z Q W represents the plan of a quarter-circle to which the sides of the solid Z X and X W represent plan tangents; also the lines Z V and V U represent the tangents on the cutting plane. The sides of this solid being cut on a common angle of inclination, the heights from the base X and Y to X V and Y T are alike, and therefore a line drawn on the cutting plane from V to T will be a level-line; and at the base a line drawn from X to Y will be a level line common to both planes. At any points on the curve at the base parallel to the level line X Y, draw O H and P N; parallel to X V draw H R and N L: parallel to V T draw L M and R S; make L M equal N P, and R S equal H O; make V J equal X Q; then the curve Z S J M U will lie perpendicularly over the plan-curve at the base Z O Q P W.

Fig. 2. Construction of a Paper Representation of a Solid with its Curved Lines and Angles as Given in Perspective and Explained at FIG. 1.—Let Y W X Z be the square base of the solid; on Y as centre describe the quarter-circle W Q Z; prolong X W both ways to C and V, Z X to E, W Y to 3, and F and Y to B. Let X V Z be the angle of inclination over X Z; make Z X E, W K and K F each equal X V; connect K E and F E: then K F E will be the same angle of inclination over W X as X V Z is over X Z; make W D, D C, Y B and Y 3 each equal X V; connect C B and 3 Z. Through Z W draw A A; on Z as centre with A A for radius describe an arc at U; on V as centre with V Z as radius intersect the arc at U; and again on Z as centre with Z 3 for radius describe an arc at T; and on V as centre with X Y for radius intersect the arc at T; connect Z T, T U, V U and V T; at right angles to Z T draw T 2; from K draw K 1 at right angles to E F; at any points on the plan-curve draw P N and O H parallel to Y X; draw N G parallel to W F, and H R parallel to X V; draw R S and L M parallel to V T; make L M, V J and R S equal H O, X Q and N P; through Z S J M U trace a curve that will lie perpendicularly over the plan-curve W P Q O Z.

With a sharp-pointed instrument scratch the lines A B, B C, C D, D A and H A; cut out the remainder of the figure and touch the adjoining edges with a little glue or thick mucilage and bring them together, leaving all lines on the outside, so that their connections may be seen and understood.

Fig. 3. Plan of Hand-rail a Quarter-circle, the Plan-tangents Z X and W X to Have the Common Angle of Inclination, X V Z and W F X. Through W Z draw A A with X F as radius; on X as centre with X F as radius describe the arc F A and A: then A A will be the distance on the cutting plane over W and Z; and if lines be drawn from A to X and A X, then A X and A X will be the length and angle of tangents on the cutting plane. From B, parallel to X Y, draw B J; from N, parallel to W F, draw N M. To find the angle for squaring the wreath-piece at both joints: Make X E equal X G; connect E Z: then the bevel at E will give the angle sought. By reference to FIG. 2 when put together as a solid it will be seen that the line T 2, which is parallel to the joint required at U, is on the inclination of the cutting plane—or face of plank—in that direction, and with the line I K—which is on the vertical plane—will be the angle of a plumb-line on the butt joint of such a wreath-piece as this centre line Z U applies to. 2 T of FIG. 2 equals Z E of FIG. 3; K I equals X G E of FIG. 3, and the angle T 2, I K of FIG. 2 equals the angle Z E X of FIG. 3.

Fig. 4 Face-mould over a Quarter-circle, the Tangents of a Common Inclination, as Given and Explained at the Plan Fig. 3.—On a line F Z make K Z and K F each equal A K of FIG. 3; make K V at right angles to Z F, and equal to K X of FIG. 3; connect Z V and F V; make F N and Z H each equal F M of FIG. 3; through H and N draw T D and J B, at right angles to F X; make V S K equal X S K of FIG. 3; make H T and H D, and N J and N B each equal N J and N B of FIG. 3. Through F draw B I; make F I equal F B; through Z draw D I; made Z I equal Z D; through I T S J I on the convex, and D K B on the concave, trace the curved edges of the face-mould. The joints Z and F are made at right angles to the tangents. The slide-line will be explained further along.

Fig. 5. Parallel Pattern for Round Rail, or to be Used Instead of the Face-mould (as a Means of Saving Stuff) for Marking the Wreath-piece on the Rough Plank.—On the line A A make K A, K A each equal K A of FIG. 3; at right angles to A A draw K X, equal to K X of FIG. 3; connect X A, X A and make the joints A, A at right angles to A X; make A N, A N each equal F M of FIG. 3; make N P, N P each at right angles to A A, and equal to N P of FIG. 3; make X Q equal X Q of FIG. 3. describe circles on the centres A P Q P A of any required radius for width of pattern. *For ordinary-sized hand-rails—such as 2" thick by 3" wide, 2¼" thick by 3½" wide, 2½" thick by 4" wide—any wreath-piece may be worked out of stuff as thick as the width of hand-rail, with a parallel pattern like* FIG. 5 *about ¾" wider than the width of the hand-rail.* See PLATE NO. 56, FIGS. 6 and 7.

Fig. 6. Exhibits the two Solids Presented—that of Fig. 1, Plate No. 10, and Fig. 1. of This Plate—brought together, the quarter-circle of each completing the plan of a semicircle on the horizontal plane and showing the vertical trace of the semicircle on the cutting planes of the two differently-cut solids.

Fig. 7. This Solid is Reproduced Half the Size of Fig. 1, merely to be Used for the Purpose of Showing the Correctness of A A and the Angles A A X, as Described at Fig. 3.—In this figure V T, as before explained, is a level line on the cutting plane, and X Y the position of a level line on the horizontal plane common to both planes. Now if a vertical plane be conceived with Z W as base, it would touch F and Z on the cutting plane, and F Z on that plane would be the distance required in position on the horizontal plane. Extend the base of the vertical plane W Z to A A indefinitely. On the horizontal plane, X being vertically under V of the cutting plane, and V I and X K measuring alike on both planes, set one foot of the compasses on X, and with Z V or V F for radius describe arcs at A A: then A X A and their angles on the horizontal plane will equal the angles Z V F on the cutting plane.

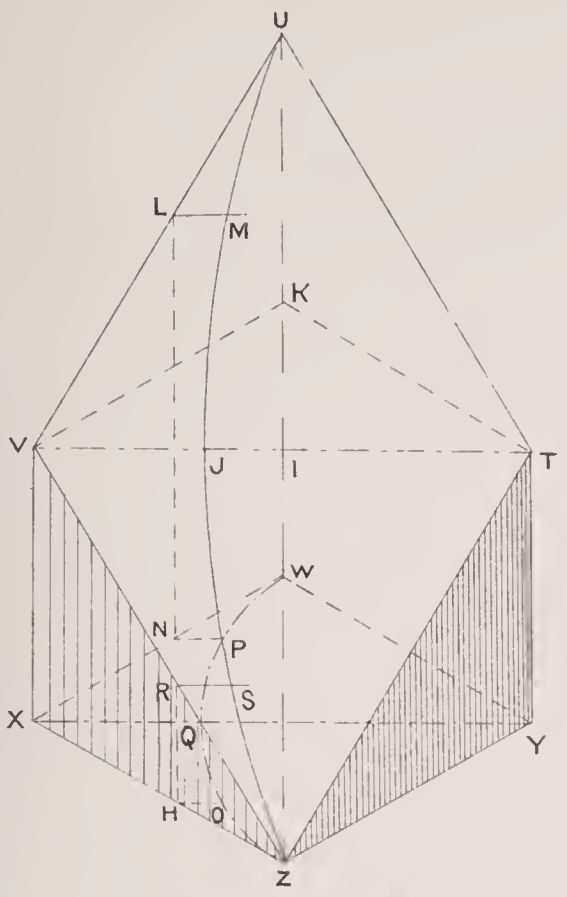


FIG. 1.

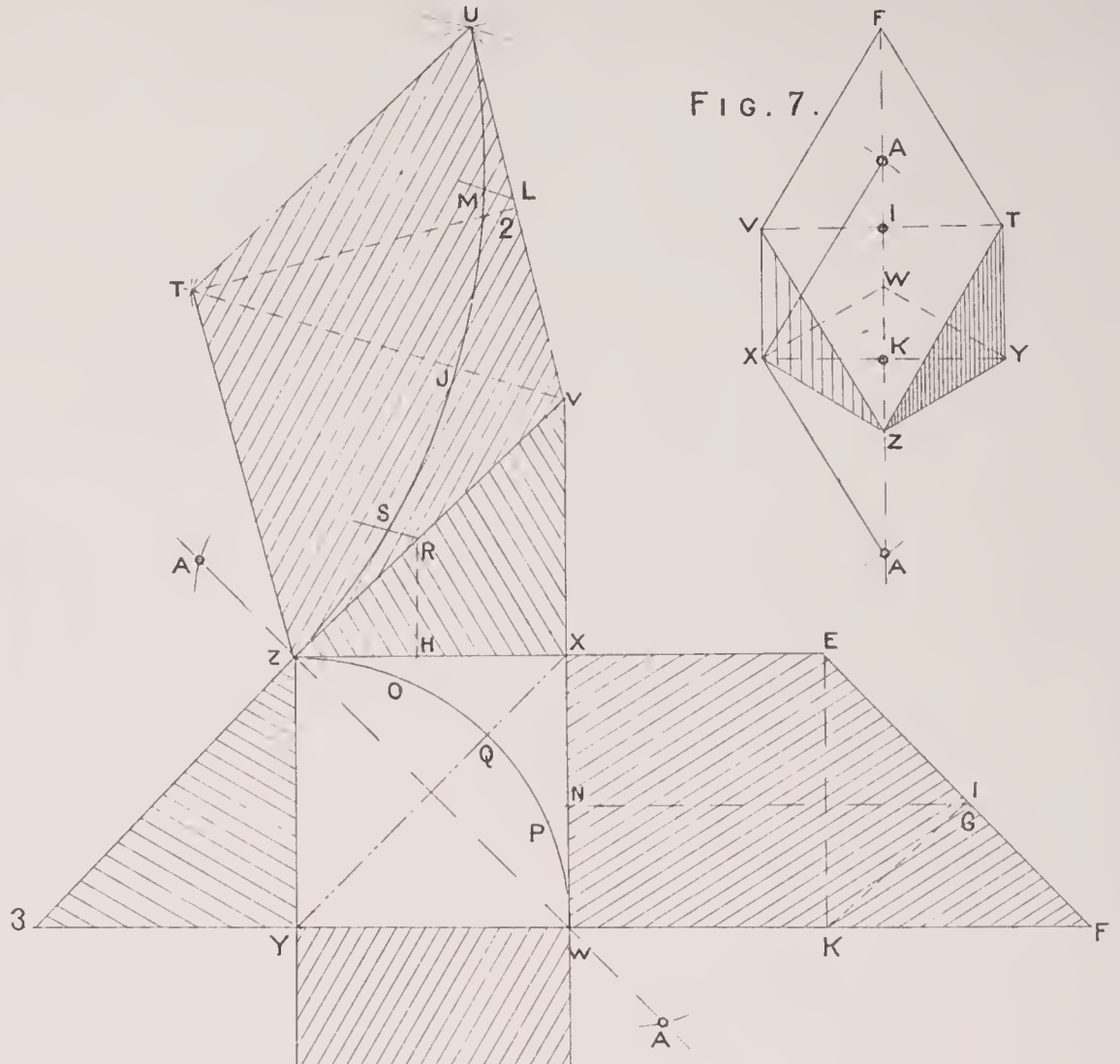


FIG. 2.

FIG. 7.

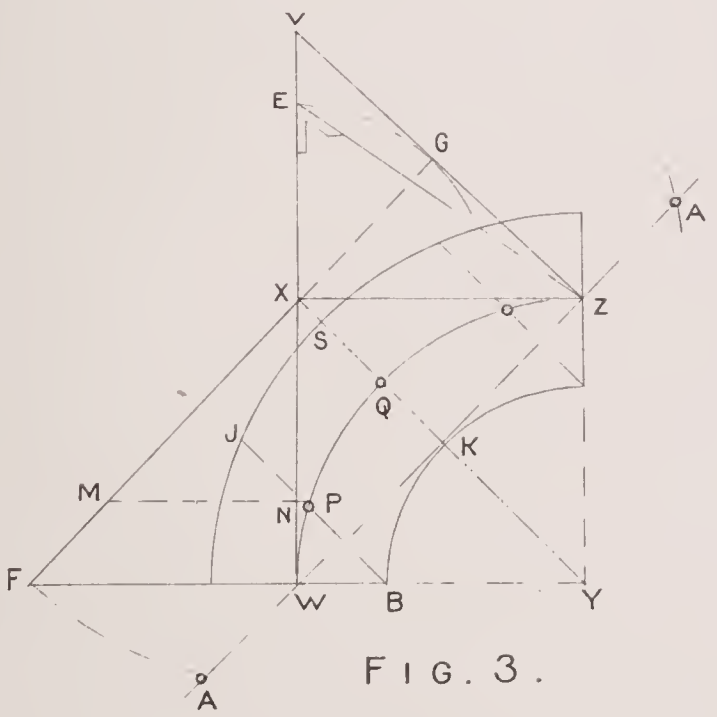


FIG. 3.

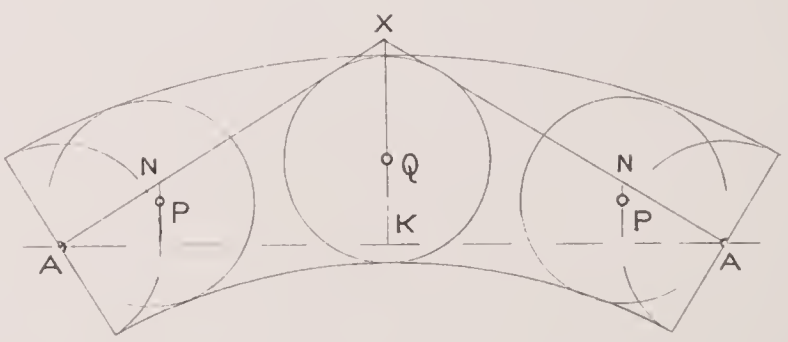


FIG. 5.

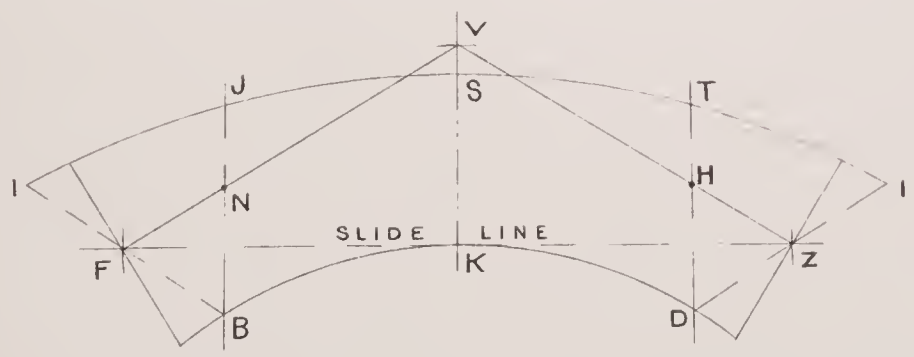


FIG. 4.

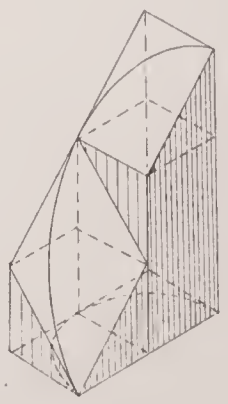


FIG. 6.

PLATE 12.

Fig. 1. Represents a Solid Block or Prism Standing Vertically on a Square Base A B C D, the Upper End Cut on an Inclined Plane Containing the Two Different Inclinations A E B and ⊏ G F.—Let A N C represent a quarter-circle to which the sides of the solids A B and B C are tangent. To find the direction of a level line on the cutting plane from the point H: make C I equal D H, connect H I; draw I J parallel to the base C B: then J H will be the level line sought. Draw J M parallel to E B: then M D on the horizontal plane will be the direction of a level line common to both planes; again, from the point E, a level line E O will be found by making D Q and T O equal to B E; then B T on the horizontal plane will be the direction of a level line as before. These level lines T B, O E, D M and J H, being all of the same length, so all level lines drawn on the base to which perpendicular lines and level lines on the cutting plane are drawn, and equal measurements taken from the curve at the base (as B N and E P), will give the trace of the curve on the cutting plane perpendicularly over that at the base. As the sides of the solid A B and B C at the base, are tangent to the curve, so A E and E G are tangent to the curve traced on the cutting plane. *A level line common to both planes may be demonstrated as follows: prolong the inclination* G H *until it meets the prolongation of the horizontal plane* C D *at* R; *also continue the inclination* G E *until it meets the continuation of the base* C B *at* S; *connect* S R: *then* S R *is the intersecting line of the plane of the two inclinations* G E *and* E A, *and the horizontal plane* C R *and* C S; *also* S R *is the position of a level line common to both planes.*

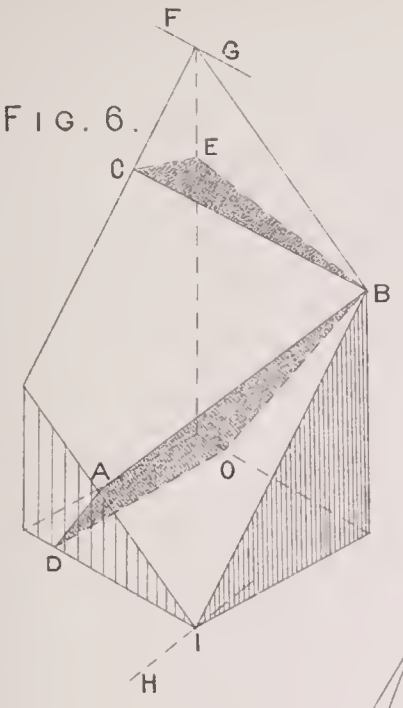
Fig. 2. Construction of a Paper Representation of the Solid with Its Curved Lines and Angles as Given in Perspective and Described in Fig. 1.—Let A B C D be the square base of the solid; on D as centre describe the quarter-circle A U V C. Prolong B C both ways to Z and N; D C to Y and I; A D to P and A B to M. Let B Z A be the inclination of the plan tangent B A; make B M and C K each equal B Z; let K I M be the inclination of the plan tangent C B; let C O, D P and D Y each equal K I; make O N equal B Z; connect N P and Y A. To find the direction of a level line on the horizontal plane from the point B, make D 2 equal B Z, draw 2 3 at right angles to Y D; and 3 X parallel to Y D: then X B will be the direction of the line sought; to find the level line from the point D, make C J equal D Y, and draw J L parallel to C B; from L draw L W parallel to C I: then D W will be the direction of a level line common to both planes from the point D. From A and C at right angles to the level lines X B or W D, draw A G and C H indefinitely; with Z A as radius on B as centre describe an arc at G, and with M I as radius on B describe an arc at H: then H G will be the distance on the cutting plane over C A of the plan, and if lines are drawn from H to B, and from G to B, the lengths and angle of tangents on the cutting plane will be given. With M I as radius set one leg of the compasses on X and describe an arc at E, and with H G as radius, on A intersect the arc at E, connect Z E, make Z T equal M L; on A with A Y as radius describe the arc Y F; with Z A as radius on E intersect the arc at F; connect E F and F A; connect F T; on A describe the arc 3 Q; connect Q Z; make Z R equal B U, and T S equal W V: then the curve A R S E will be the trace on the cutting plane perpendicularly over the curve at the base. From F at right angles to A F draw the line F 4, and from F at right angles to F E draw F 6; from P at right angles to P N draw P 8; from J at right angles to I M draw J 5. With a sharp-pointed instrument scratch the lines A B C D, and Z A; then with a sharp knife cut through the outlines of the figure, and touch the adjoining edges with a little glue or thick mucilage and bring them together, leaving all lines on the outside for examination.

Fig. 3. Plan of Hand-Rail a Quarter-Circle in which the Tangents to the Centre Line C B and A B Require Two Different Inclinations as B E C and A S B.—The plan of rail in every case consists simply of the convex and concave curve lines embracing the width of the rail, also the centre curve line and its tangents; there has then to be added to this plan certain lines, which in their position fix the kind of face-mould required, and supply points of measurement from which to draw the face-mould. Let the inclination of the tangents B E C and A S B be first fixed, then find the direction of a level line common to both planes as follows: Make B F equal A S; draw F J parallel to B C; from J draw J I parallel to E B; connect I D: then I D will be the level line sought. Parallel to D I draw L 6, R B and P X; from 8 parallel to B E draw 8 W; from V parallel to A S draw V U. To find the distance over C A on the cutting plane: from C and from A, at right angles to I D, draw C H and A G indefinitely; with C E as radius set one foot of the compasses on B and describe the arc at H, and with B S as radius on B describe the arc S G; connect G H: then G H will be the distance sought; and if B H and B G are connected the lines will contain the angle and length of tangents on the cutting plane. To find the angles with which to square the wreath-piece: prolong B C to Z; make C Z equal I K; connect Z D: then the bevels at Z will give the plumb line to square the wreath-piece at the butt-joint over C. Continue B A to Q; make A Q equal A T; connect Q R: then the bevel at Q will give the plumb line to square the wreath-piece at the butt-joint over A.

Fig. 4. Face-mould Over a Plan of a Quarter-circle, the Tangents of Two Different Inclinations as Given at Fig. 3.—Draw the line C A and make C O and O A equal H O and O G of Fig. 3. On C with the radius C E of Fig. 3 describe an arc at E; on O with the radius O B of Fig. 3 describe an intersecting arc at E, and on A with the radius B S of Fig. 3 intersect the arc at E; connect C E, A E and O E; make C, 8, I equal C W J of Fig. 3; make E V equal B U of Fig. 3. Parallel to O E through 8, I, V draw L 6, M Y and P X; make 8, 6, 8 L, I Y, I M, E 4 N and V X and V P each equal the corresponding letters of Fig. 3. Through C draw L B; make C B equal C L; through A draw P D; make A D equal A P. Through L M N P on the concave, and B 6 Y 4 X D on the convex, trace the curves of the face-mould. The joints A and C are made at right angles to the tangents A E and C E. The slide line is drawn anywhere on the face-mould at right angles to the level line O E.

Fig. 5. Parallel Pattern for Round-rail or to be Used Instead of the Face-mould—as a Means of Saving Stuff—for Marking the Wreath-piece on the rough Plank.—Make H O and O G each equal H O and O G of Fig. 3. The tangents H B and G B, and the level line B O, are the same as Fig. 4. Make H I and B V equal C J and B U of Fig. 3; draw I, 5 and V 2 parallel to O B; make V 2, B 3 and I, 5 each equal the corresponding letters and figures at Fig. 3. The joints are made at right angles to the tangents. Describe circles on the centres H 5, 3, 2 G, of any required radius for width of pattern. Fig. 6.—*A solid similar to* Fig. 1 *introduced to call attention to the two sections that may be cut in a direction on the inclined plane, at right angles to each of the differently inclined sides or tangents, as* A B *and* B C; *and also cut down the sides of the solid in a direction at right angles to each inclination of the cutting plane as* A D *and* C E. *The inclined plane of these solids should be understood as representing the surface and position of rail plank; the lines* A B *and* B C *the direction of joints of face-moulds; and the lines* A D *and* C E *represent the joints square through the thickness of plank. The angle* B C E *will square the wreath-piece at the butt-joint* F G; *and the angle* B A D *squares the wreath at the joint* H I. *The sections here given and described are also outlined on the paper solid to be formed at* Fig. 2 *by the lines* F 7, 7, 6 *and* P 8, *also* F 4 *and* J 5.

FIG. 6.



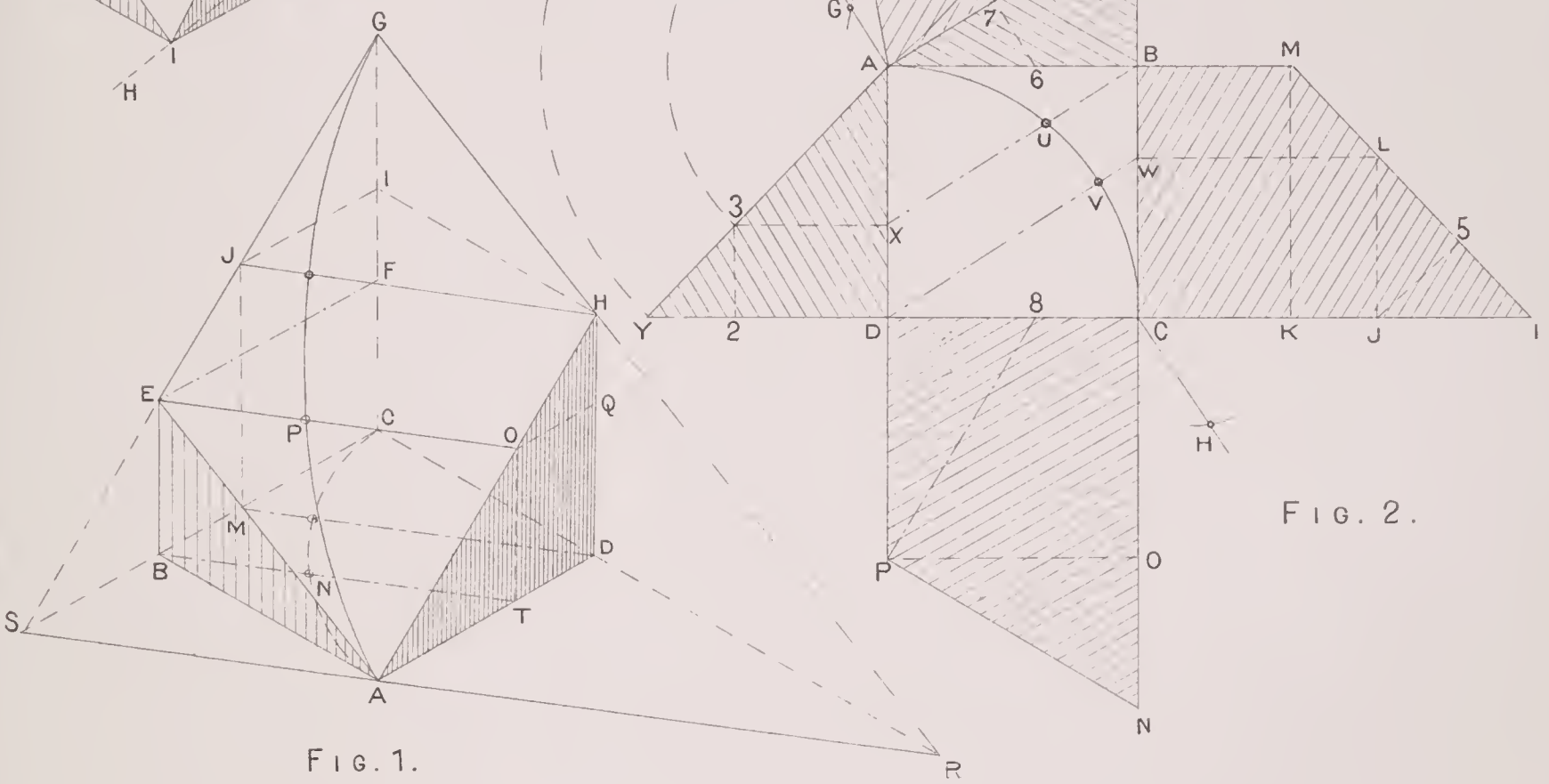


FIG. 2.

FIG. 1.

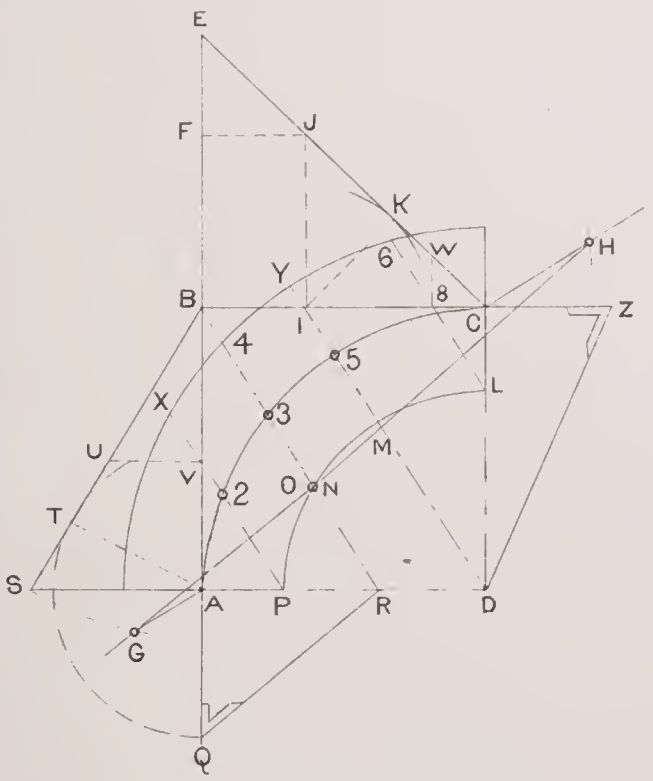


FIG. 3.

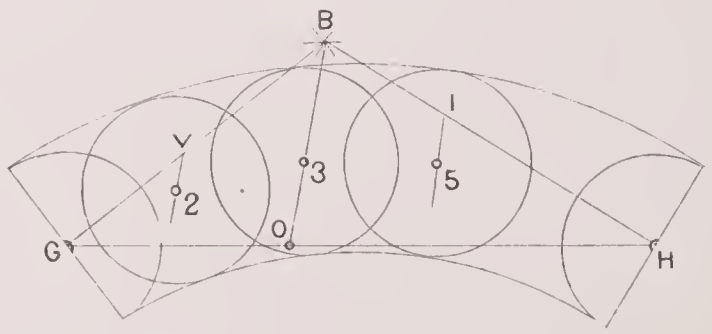


FIG. 5.

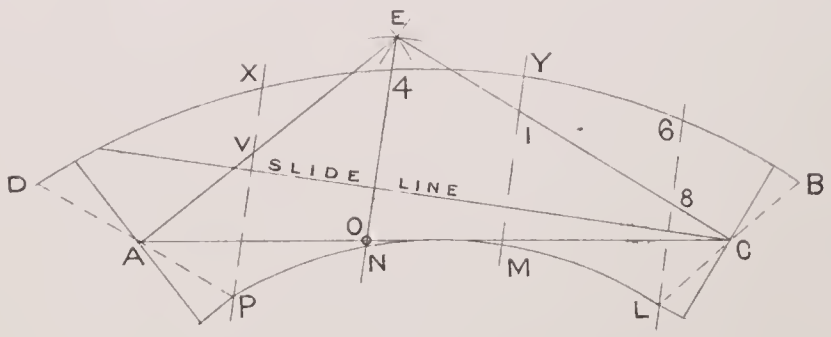


FIG. 4.

PLATE 13.

Fig. 1. Represents a Solid Block or Prism Standing Vertically on a Base A B P O, **the Sides of Which are Parallel, and Have Two Obtuse and Two Acute Angles.**—The upper end of this prism is cut on the inclination P M B, and M N at right angles to the sides, and parallel to the base P O. In this solid B A, being in the horizontal plane, and also terminating the inclined plane, is a level line common to both planes. On the base describe the curve A D J P tangent to the sides of the solid A B and B P. To find the trace of this plan curve on the cutting plane: parallel to A B on the base and at pleasure draw C D and G J; at G and C parallel to P M draw G K and C E; from E and K parallel to B A draw K L and E F; make E F equal C D, and K L equal G J; through the points A F L M on the inclined plane trace a curve perpendicularly over the plan curve A D J P. As the sides of the solid A B and B P at the base are tangent to the plan curve, so A B and B M are tangent to the curve traced on the cutting plane.

Fig. 2. Construction of a Paper Representation of the Solid With its Curved Lines and Angles Given in Perspective and Described at Fig. 1.—Let A B P O be the form of the base, the opposite sides of which are parallel and equal. From A at right angles to B A draw A X; from P at right angles to B P draw R X; on X as centre describe the plan of curve A D J P, tangent to the sides of the base B A and B P. Let P R B be the inclination—assumed or required—over the base B P; make O N and P M at right angles to O P and each equal P R; connect N M; make O U at right angles to A O and equal to P R; connect U A; parallel to B A from any points on the curve D and J draw J G and D C; parallel to P R draw C E and G K; on B with B R as radius describe the arc Q R S indefinitely; on A with A Q as radius intersect the arc at S; connect S B; on A with A U as radius describe an arc at T; on S with B A as radius intersect the arc at T; connect A T and T S. On B as centre describe the arcs K W and E V; draw V F and W L parallel to B A; make V F and W L equal C D and G J; through S L F A trace a curve on the cutting plane that will lie perpendicularly over the plan curve A D J P. With a sharp-pointed instrument scratch the lines A B P O A; cut out the remainder of the figure and touch the adjoining edges with a little glue or thick mucilage and bring them together, leaving all lines on the outside for examination and study.

Fig. 3. Plan of Hand-rail Less than a Quarter-circle, the Tangents to the Centre Curve Line A P **Forming the Obtuse Angle** P B A.—From P draw P M and P 5 at right angles to B P; draw A 5 at right angles to B A; on 5 as centre describe the curve A P. The position of the tangent A B is horizontal, while over the tangent B P the inclination P M B is required. Draw T O, R L, U G and X C parallel to B A; parallel to P M draw J K, F I E, S N and O Q; from P at right angles to B A draw P 4; on B with B M as radius describe the arc M 4: *then* 4 A *will be the distance over* A *and* P *on the cutting plane, and if a line be drawn from* 4 *to* B, *then* 4 B A *will be the length and angle of tangents on the cutting plane.* To find the angle for squaring the wreath-piece at the joint over P: draw E Z parallel to B P; from F parallel to B M draw F H; draw X Y at right angles to P M; make X Y equal P H; connect Y Z: then the bevel at Y will give a plumb-line on the butt-joint over P, which is the angle sought. To find the angle for squaring the wreath at the joint over A: make D C equal J K; connect C A: then the bevel at C will give a plumb-line on the butt-joint and the angle sought.

Fig. 4. Face-mould Over a Plan of Less than a Quarter-circle with One Tangent Fixed in the Horizontal Plane, the Other Inclined as Given at the Plan of Hand-rail, Fig. 3.—Make M W equal A 4 of FIG. 3; with B M of FIG. 3 as radius set one foot of the compasses on M and describe an arc at B; on W, with A B of FIG. 3, intersect the arc at B; connect W B and B M. Make the joints W and M at right angles to the tangents. Make M K I N equal M K I N of FIG. 3; through K I N parallel to W B draw C L, A J and E G; make K G equal J X, and K E equal J W of FIG. 3; through M draw G F; make M F equal G M; make I J and I A equal F G and F U of FIG. 3; make N L and B 6 equal S L and B 6 of FIG. 3; make W D equal W C. Through G J L 6 D on the convex and F E A C of the concave trace the curved edges of the face-mould.

Fig. 5. Parallel Pattern for Round-rail or to be Used Instead of the Face-mould as a Means of Saving Stuff, and for Marking the Wreath-piece on the Rough Plank.—Make A M equal A 4 of FIG. 3; make the tangents M B and B A equal M B and B A of FIG. 3; make M F O equal M I Q of FIG. 3; make F V and O T equal F V and O T of FIG. 3. The joints are at right angles to the tangents. On M V T and A, describe circles of any required radius for width of pattern.

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* Tangents to any plan curve that includes less than a quarter-circle, or a curve that measures less than ninety degrees, always form obtuse angles.

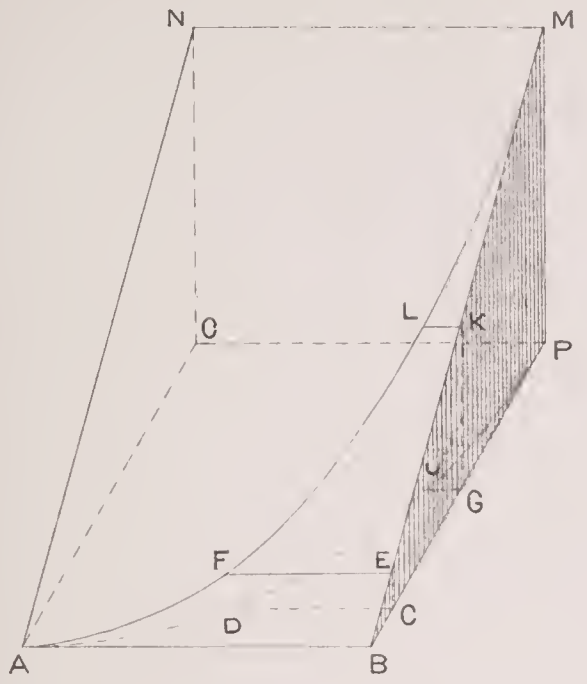

FIG. 1.

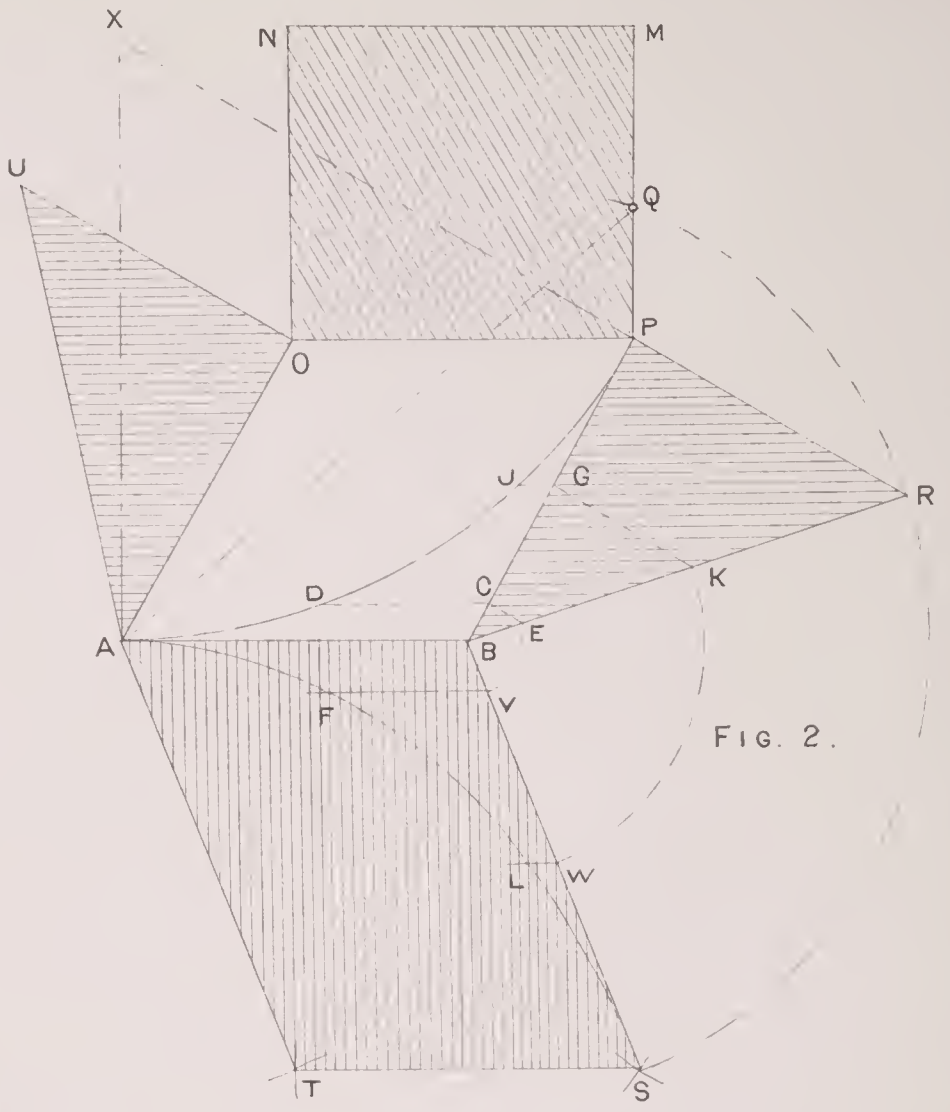

FIG. 2.

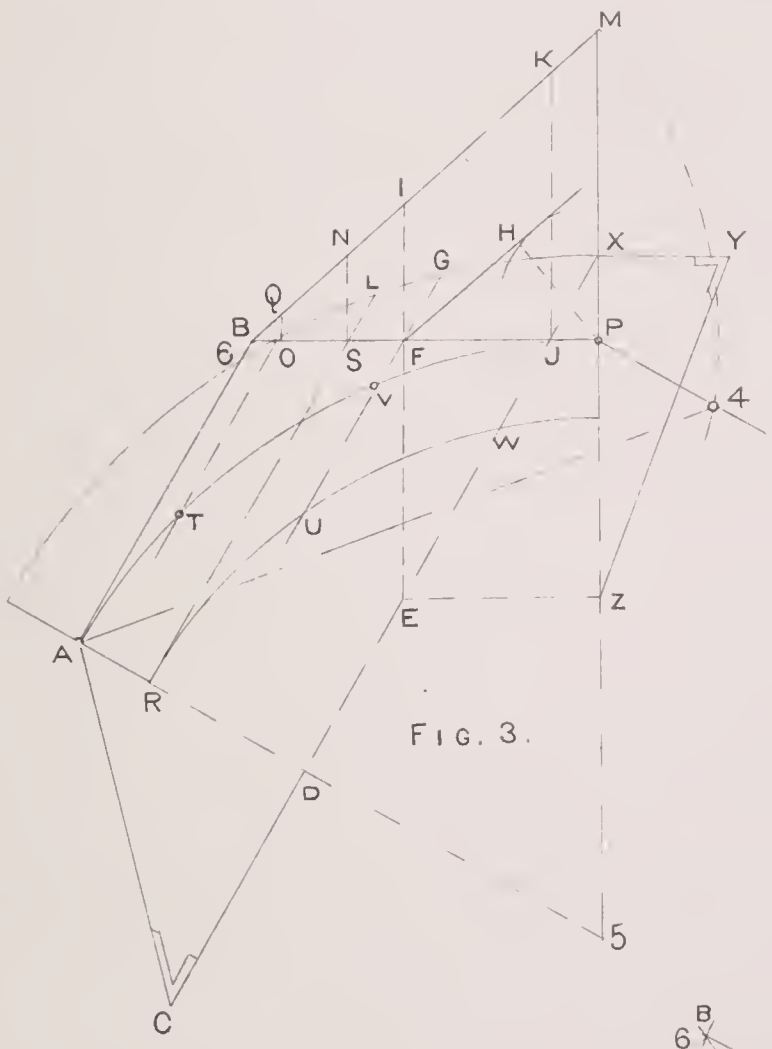

FIG. 3.

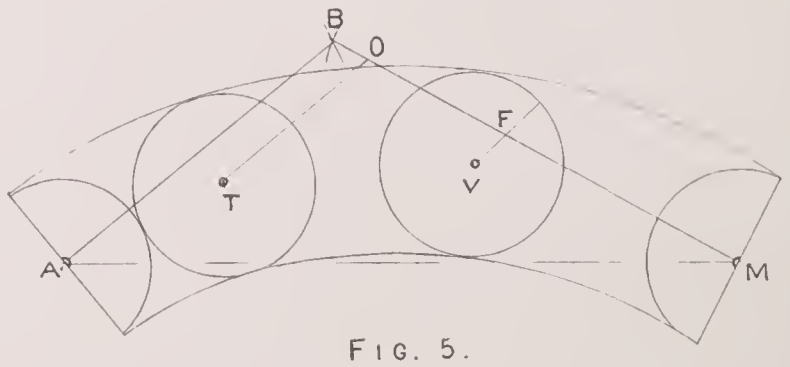

FIG. 5.

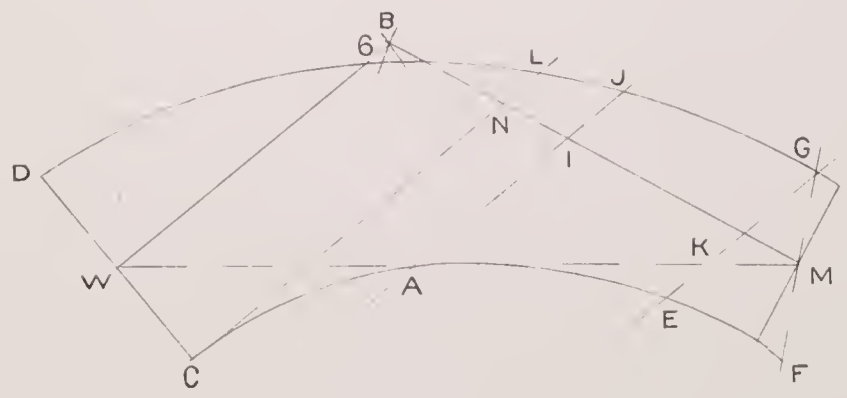

FIG. 4.

PLATE 14.

Fig. 1. Represents a Solid Block or Prism Standing Vertically on a Base A B C D the Sides of which are Parallel and Have Two Acute and Two Obtuse Angles.—The upper end of this prism is cut on the inclination C E B, and on the line E G at right angles to the sides and parallel to the base C D. The base line B A of this solid, being in the horizontal plane and also terminating the inclined plane, is a level line common to both planes. On the base draw the lines A Y and C Y at right angles to the tangents; on Y as centre draw the plan curve A L H C. *At* PLATE No. 13, FIG. 1, *the solid is precisely like this, but the obtuse angled tangents to the curve were required in that case, because the plan curve was less than a quarter-circle; here, however, the acute angle must be used because the plan curve is greater than a quarter-circle.** At any points on the curve as L and H parallel to A B draw L O and H J; parallel to C E draw O N and J K; from K and N parallel to A B draw N M and K F; make N M equal O L and K F equal J H; through the points A M F E trace a curve on the cutting plane, which will lie perpendicularly over the plan curve A L H C. As the sides of the solid A B and B C at the base are tangent to the plan curve, so A B and B E are tangent to the curve traced on the cutting plane.

Fig. 2. Construction of a Paper Representation of the Solid with its Curved Lines, Surfaces and Angles as Given in Perspective and Described at Fig. 1.—Let A B C D be the form of the base, the opposite sides of which are parallel and equal. Draw A Y and C Y at right angles to the tangents; on Y as centre describe the plan curve A O L C. Let C E B be the inclination over the base C B; make C H and D G at right angles to C D and equal to C E; connect H G; make D I at right angles to A D and equal to D G; connect I A. On B with B E for radius describe the arc E F and the arc K; on A as centre with A I as radius, describe an arc at J; on A as centre with A F as radius intersect the arc at K; with B A for radius on K intersect the arc at J; connect A J, J K and K B. Parallel to A B from any point on the curve O and L draw O N and L M; parallel to C E draw M P and N R; make B U T equal B R P; parallel to B A draw U Q and T S; make U Q and T S equal N O and M L. Through K S Q A trace a curve on the cutting plane that will lie perpendicularly over the plan curve A O L C. With a sharp-pointed instrument scratch the lines A B, B C, C D and D A; cut out the remainder of the figure and touch the adjoining edges with a little glue or thick mucilage and bring them together, leaving all lines on the outside for comparison and study.

Fig. 3. Plan of Hand-rail Greater Than a Quarter-circle, the Tangents to the Centre Curve Line A C Forming the Acute Angle A B C.—Draw C Y, C E at right angles to C B; draw A Y at right angles to A B; on Y as centre describe the centre curve line A N M C. The tangent A B is to remain level, and over the tangent B C the inclination C E B is required. Through I and T draw I R and T V parallel to A B; at any point on the curve as X draw K G parallel to A B; parallel to C E draw Q O, K L and V P. From C at right angles to A B draw C F indefinitely; on B as centre with B E as radius describe the arc E F: *then* A F *will be the distance over* A *and* C *on the cutting plane; and if a line be drawn from* F *to* B, *then* F B A *will be the length and angle of tangents on the cutting plane.* To find the angle for squaring the wreath-piece at the joint over C: From K draw K H parallel to B E; make C S equal C H; connect S J: then the bevel at S will give a plumb line on the butt-joint which is the angle sought. To find the angle for squaring the wreath-piece at the joint over A: make Z G equal K L; connect G A: then the bevel at G will give a plumb line on the butt-joint over A and the angle sought. *In finding angles for squaring wreath-pieces as much of the joint lines as are convenient may be taken, as follows: Prolong the joint line* C Y *until it meets the continuation of the level line* B A *at* 8, *make* C 6 *equal* C 5; *connect* 6, 8, *and the same angle will be given at* C, 6, 8 *as at* C S J; *and again at joint* A; *from* C *draw the line* C 7 *parallel to* B A; *prolong the joint line* A Y *to* 2; *make* 2, 7 *equal* C E: *connect* 7 A; *then the angle* 2, 7 A *equals the angle* Z G A.

Fig. 4. Face-mould Over a Plan of Hand-rail More Than a Quarter-circle, the Plan Tangents Forming an Acute Angle, One of the Tangents to Remain Level, the Other Inclined, as Given at the Plan Fig. 3.—Make A E equal A E of FIG. 3, with E B of FIG. 3 as radius; set one foot of the compasses on E and describe an arc at B; on A with A B of FIG. 3 as radius intersect the arc at B; connect E B and A B; make E O L P equal E O L P of FIG. 3. Parallel to A B draw P C, L D and O F, O G; make O G, O F equal Q I and Q R of FIG. 3; connect G E H; make E H equal E G; make L J D equal K 3 X of FIG. 3; make P K C equal V W T of FIG. 3; make B M equal B U of FIG. 3. The joints E and A are at right angles to the tangents. Make A N equal A C. Through the points H F J K M N on the convex and C D G of the concave trace the curved edges of the face-mould.

Fig. 5. Parallel Pattern for Round-rail, or to be Used Instead of the Face-mould as a Means of Saving Stuff, and for Marking the Wreath-piece on the Rough Plank.—A E B equals A F B of FIG. 3; E L P equals E L P of FIG. 3; L M and P N equals K M and V N of FIG. 3. The joints are at right angles to the tangents. On E M N A as centres describe circles of any required radius for width of pattern.

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* Tangents to any plan curve that includes more than a quarter-circle, or that measures more than ninety degrees, always form acute angles.

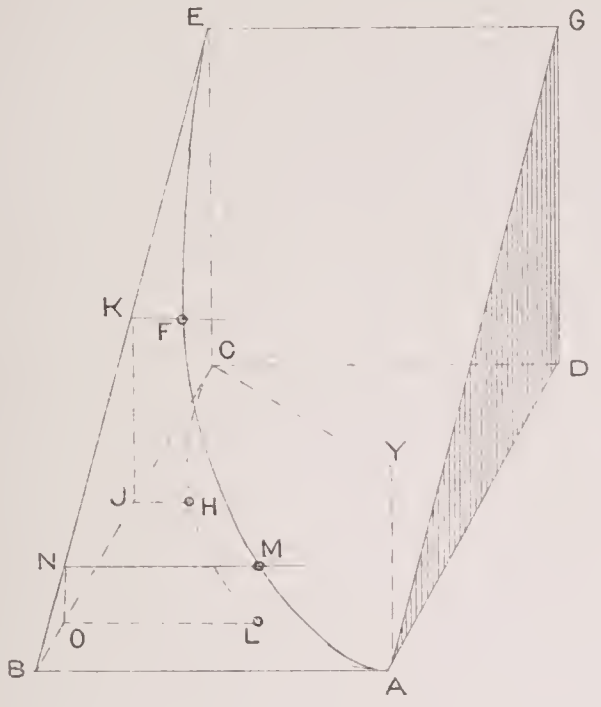

FIG. 1.

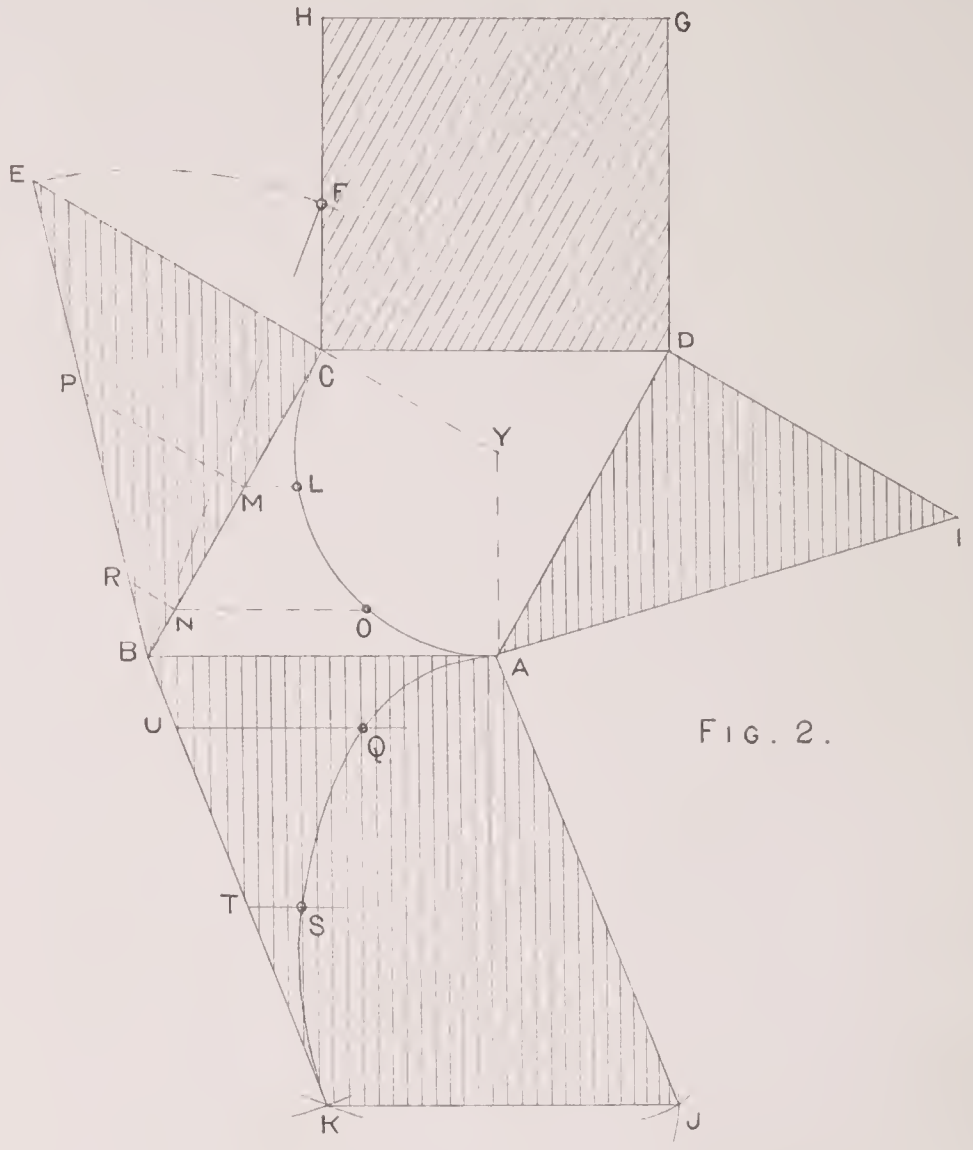

FIG. 2.

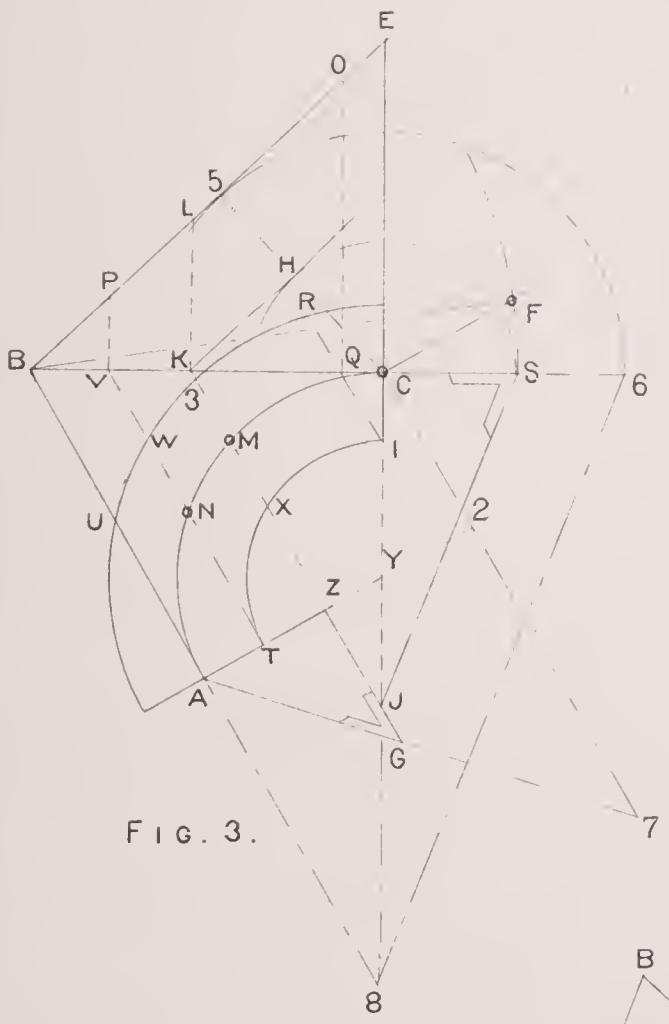

FIG. 3.

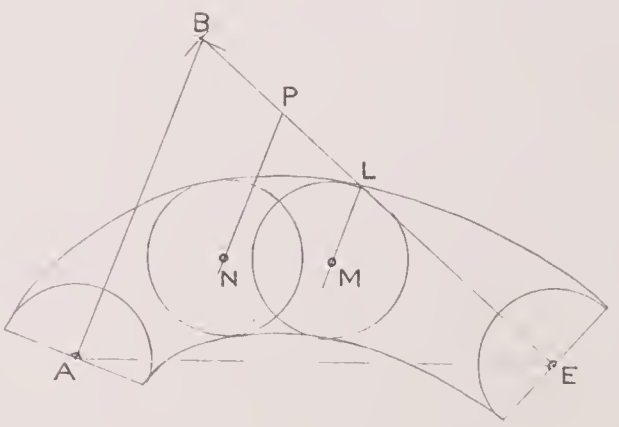

FIG. 5.

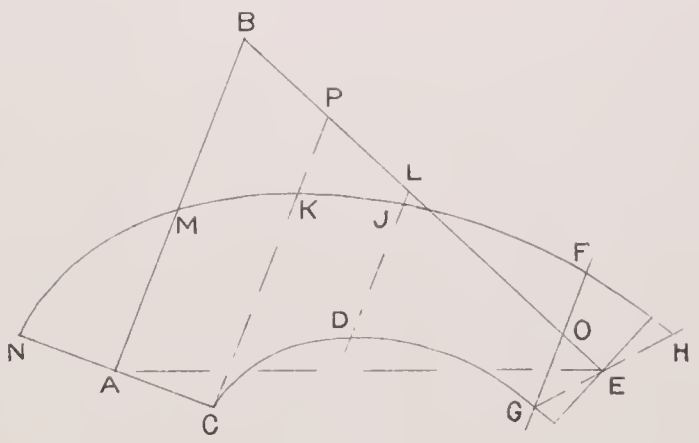

FIG. 4.

PLATE 15.

Fig. 1. Represents a Solid Block or Prism Standing Vertically on a Base A B C D, the Sides of Which are Equal and Parallel, and Have Two Acute and Two Obtuse Angles.—The upper end of this prism is cut on the angle B F A on the side A B ; and on the side B C, on the same angle of inclination G H F ; therefore, the sides of this solid have a common inclination, and a line F I drawn on the cutting plane, or B D on the horizontal plane, is a level line common to both planes. On the base A O X M C represents a plan curve less than a quarter-circle, to which the sides A B and B C of the solid represent the plan tangents ; and the lines A F and F H represent the tangents on the cutting plane. To find the trace of the plan curve on the cutting plane at any points, as O X M,* draw O J and N M parallel to D B ; parallel to B F draw J K and N Q ; parallel to F I draw Q P and K L ; make Q P equal N M and K L equal J O ; make F R equal B X ; through the points A L R P H trace a curve on the cutting plane which will lie perpendicularly over the plan curve A O X M C.

Fig. 2. Construction of a Paper Representation of a Solid With its Surfaces Curved Lines and Angles as Given in Perspective and Described at Fig. 1.—Let A B C D be the form of base the opposite sides of which are parallel and equal. Draw C X and A X at right angles to the tangents ; on X as centre describe the plan curve A J C. At right angles to A B and C D draw B F, C V and D W ; at right angles to A D and B C draw D Y, C U and B E. Let B F A be the inclination required over the base—or plan tangents—A B and B C. Make B E, C 2, 2 U, C Z, Z V, D W and D Y all equal B F ; connect U E, V W and Y A. Through C and A draw S T indefinitely ; on B as centre with F A as radius describe arcs at S and T. At any points on the curve, as I and 5, draw I K and 5 M parallel to D B ; parallel to B E draw M N ; parallel to B F draw K L ; on A with S T as radius describe an arc at H ; on F as centre with D B the level line as radius describe an arc at I ; on F with F A as radius intersect the arc at H ; on A as centre with A F as radius intersect the arc at I ; connect A I, I H, H F and F I. Make F R equal E N ; parallel to F I draw R Q and L O ; make L O equal I K, F P equal B J, and R Q equal M 5 ; through A O P Q H trace a curve on the cutting plane that will lie perpendicularly over the plane curve A J C at the base. With a sharp-pointed instrument scratch the lines A B C D A and A F ; cut out the remainder of the figure, and touch the adjoining edges with a little glue or thick mucilage and bring them together, leaving all lines on the outside so that their connections may be seen and studied.

Fig. 3. Plan of Hand-rail Less Than a Quarter-circle, the Tangents A B and B C to the Centre Curve Line A C, to Have a Common Angle of Inclination.—At right angles to B C draw C H, C R ; at right angles to A B draw A R ; connect R B : then R B is the direction of a level line common to both planes ; let C H B be the inclination assumed or required over the tangent C B, and let B V A be the same angle of inclination over the tangent B A ; B V being at right angles to A B ; through E draw E G parallel to R B ; parallel to C H draw J K. Through A C draw the line S T indefinitely ; on B as centre with B H as radius describe the arc H T and S : then S T will be the distance over C and A on the cutting plane ; and if lines be drawn from T and S to B : then the lines T B and S B will be the length and angle of the tangents on the cutting plane. *To find the angle for squaring the wreath-piece at both joints : continue* B C *to* Y *indefinitely ; make* C Y *equal* C L ; *connect* Y R : *then* C Y R *will be the angle required and the bevel at* Y *will give a plumb-line on the butt-joints of the wreath-piece over* A *and* C.

Fig. 4. Face-mould Over a Plan of Hand-rail Less Than a Quarter-circle, the Plan Tangents Forming an Obtuse Augle, and the Inclination of Both Tangents Alike, as Given at the Plan Fig 3.—Let S D and D T equal S D and D T of FIG. 3 ; draw D B at right angles to S T and equal to D B of FIG. 3 ; connect T B and S B. Make B X, B O equal B U, B Q of FIG. 3 ; make T J, S J each equal H K of FIG. 3 ; through J and J draw lines at right angles to S T or parallel to D B ; make J G and J E at both ends equal J G and J E of FIG. 3 ; through T draw E Z ; make T Z equal T E ; through S draw E Z ; make S Z equal S E. The joints S and T are at right angles to the tangents. Through Z G O G Z of the convex and E X E of the concave trace the curved edges of the face-mould.

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* As many level lines may be drawn on the plan curve for measuring trace points on the cutting plane, as for face-moulds as seem desirable. But in drawing face-moulds, certain points on the plan must always be taken with the level measuring lines ; as, for instance, the angle of tangents B, and the points E, both of FIG. 3.

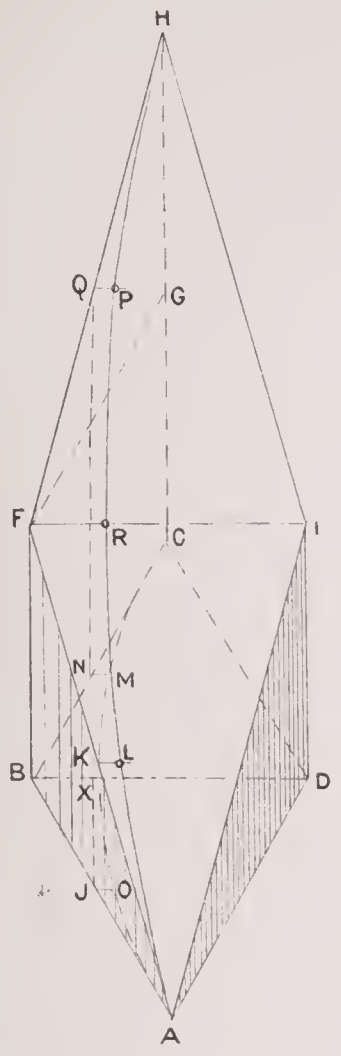

FIG. 1.

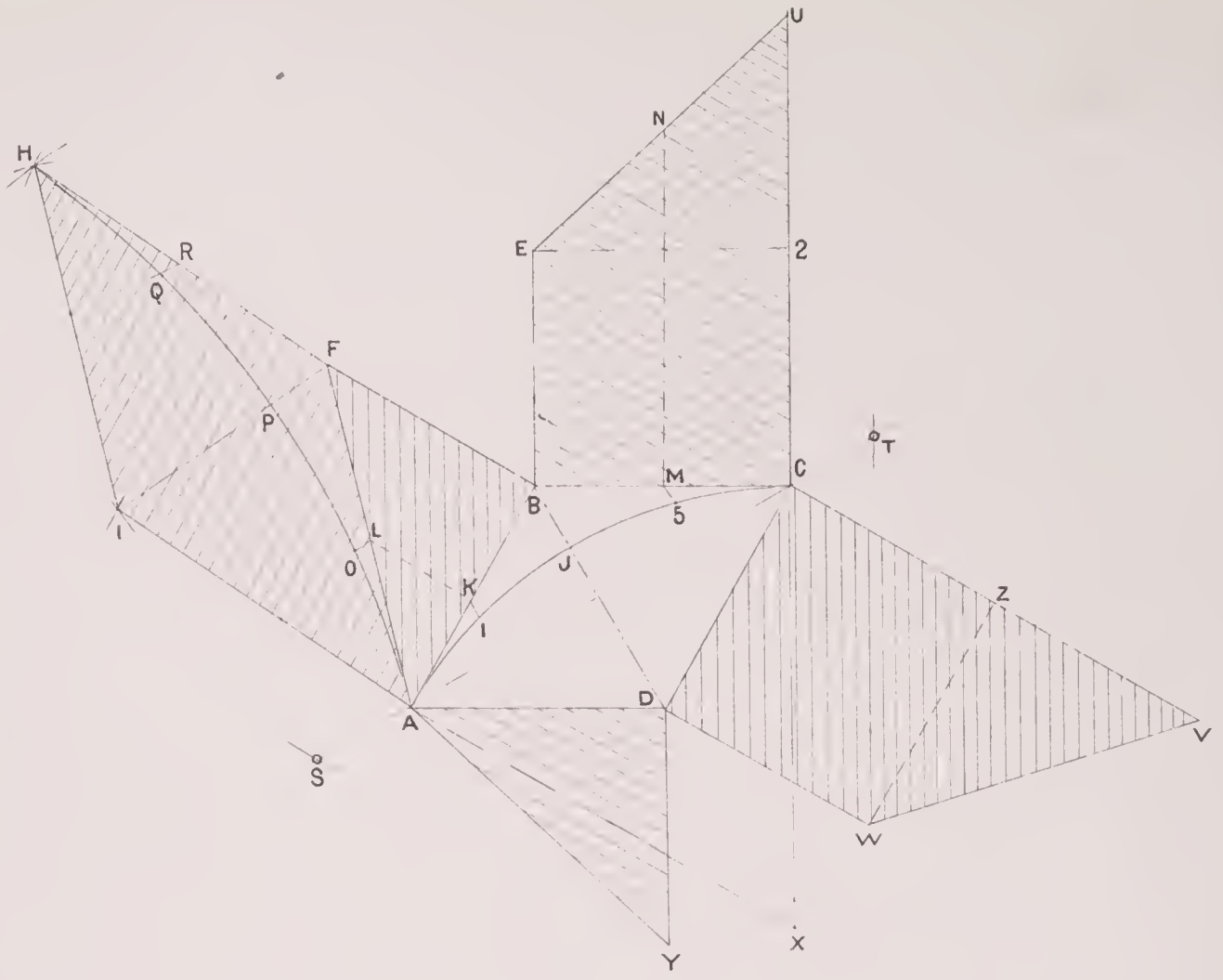

FIG. 2.

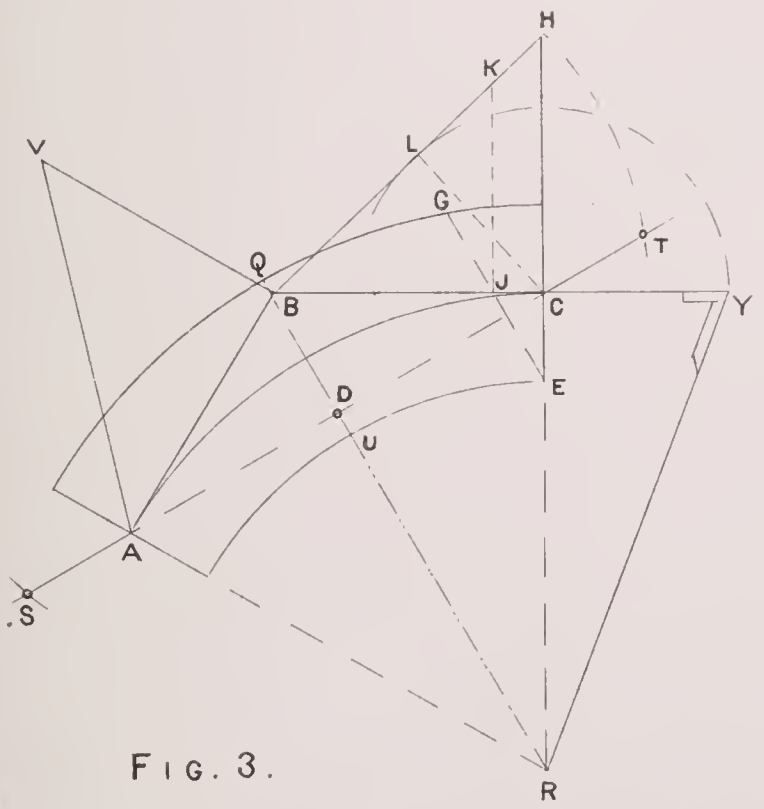

FIG. 3.

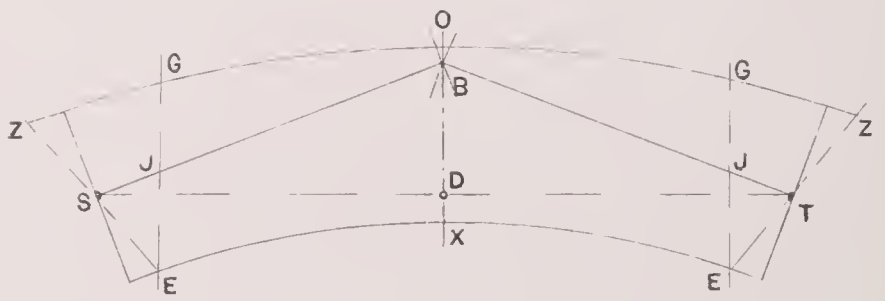

FIG. 4.

PLATE 16.

Fig. 1. Represents a Solid Block or Prism Standing Vertically on a Base A B C D the Sides of which are Equal and Parallel and have Two Acute and Two Obtuse Angles; the Upper End of the Solid is Shown as Cut on Two Different Angles: the Side A B on the Angle B M A, and the Side B C on the Lesser Angle V Q M.*—On the base A E G H C represents a plan curve less than a quarter-circle, to which the sides A B and B C of the solid represent the plan tangents, and the lines A M and M Q represent the tangents on the cutting plane. Make B L equal D S, draw L J parallel to A B, connect J S; then J S will be a level line on the cutting plane. Make J F parallel to B M, connect F D; then F D will be the direction of level lines on the horizontal plane common to both planes. At any points on the curve at the base, as E G H, draw B G and I H parallel to F D; parallel to B M draw I P; draw P O and M N parallel to J S; make P O equal I H, M N equal B G, and J K equal F E; through A K N O Q trace a curve on the cutting plane which will lie perpendicularly over the plan curve A E G C.

Fig. 2. Construction of a Paper Representation of a Solid with its Angles, Surfaces, and Curved Lines as Given in Perspective and Described at Fig. 1.—Let A B C D be the form of base the opposite sides of which are parallel and equal. Draw A T and C T at right angles to the tangents; on T as centre describe the plan curve A O P R C. At right angles to A B and C D draw B H, C X, and D V; at right angles to B C and A D draw B G, C F, and D U; let B H A be the angle of inclination required over the base or plan tangent A B; make B G and C I each equal B H; connect G I; make I F G the angle of inclination over the base or plan tangent B C, I F to be less in height than B H; make D U, C W and D V each equal I F; connect U A; make W X equal B H; connect X V. Make B L equal D U; draw L M parallel to B A; make M N parallel to B H: then N D will be the direction of level lines common to both planes. At right angles to D N draw C Z and A Y indefinitely; on B as centre with A H for radius describe an arc at Y, and again on B as centre with G F for radius describe an arc at Z: then Y Z will be the distance over A and C on the cutting plane, and if lines are drawn from Z to B and Y to B, then Z B and Y B will be the length and angle of the tangents on the cutting plane. From B parallel to N D draw B P, and at any point on the curve, as R, draw R Q parallel to N D. On H as centre with G F as radius describe an arc at K; on A as centre with Y Z as radius describe an arc at K; on A as centre with A U as radius describe an arc at J; on M with N D as radius intersect the arc at J; connect A J, J K and K H; make H E equal G 5; parallel to M J draw H 2 and E 4; make M S equal N O, H 2 equal B P, and E 4 equal Q R, through A S 2 4 K trace a curve on the cutting plane that will lie perpendicularly over the plan curve A O P R C at the base. With a sharp-pointed instrument scratch the lines A B, B C, C D, D A and H A; cut out the remainder of the figure and touch the adjoining edges with a little glue or thick mucilage and bring them together, leaving all lines on the outside so that their connections may be seen and understood.

Fig. 3. Plan of Hand-rail Less than a Quarter-circle, the Tangents to have Two Different Angles of Inclination, the Angle B T A over the Tangent A B, and C S B the Lesser Angle over the Tangent C B.—To find the position of a level line common to both planes: draw A L parallel and equal to B C; make B W equal C S; draw W X parallel to B A; make X U parallel to B T; connect U L: then U L will be the line sought. Parallel to U L draw P Q, B M and G H; parallel to C S draw O R; parallel to U X draw F 4. At right angles to L U draw C D and A E indefinitely; on B as centre with B S as radius describe the arc S D, and again on B as centre with T A as radius describe an arc at E: then D E will be the distance over A and C on the cutting plane; and if lines are drawn from E and D to B, D B and E B will then be the length and angle of tangents on the cutting plane.

To Find the Angle for Squaring the Wreath-piece at the Joint over C:—Prolong the tangent B C to N; make C N equal C R; connect N M: then the bevel at N will give a plumb-line on the butt-joint over C.

To Find the Angle for Squaring the Wreath-piece at the Joint over A:—Prolong the level line U L until it meets the continuation of the joint-line A K at J; prolong the tangent B A to i; make A I equal U V; connect I J: then the bevel at I will give a plumb-line on the butt-joint over A.

Fig. 4. Face-mould over a Plan of Hand-rail Less than a Quarter-circle, with Two Different Angles of Inclination over the Plan Tangents.—Let A H equal E D of Fig. 3. Make H Z equal D Z of Fig. 3. On Z as centre with Z B of Fig. 3 as radius describe an arc at B; on H as centre with S B of Fig. 3 as radius intersect the arc at B; connect H B and A B, and if the work is correct A B will equal A T of Fig. 3. Connect B Z; make H Q equal S R of Fig. 3; make A P and A R equal A 4 and A X of Fig. 3; through Q parallel to B Z draw K G, through R and P parallel to B Z draw M E and N D; make Q K and Q G equal O Q and O P of Fig. 3; make B F equal B 2 of Fig. 3; make R M and R E equal U Y and U 3 of Fig. 3; make P N and P D equal F H and F G of Fig. 3; through A draw D O; make A O equal A D; through H draw G I; make H I equal H G; through I K M N O of the convex and G F E D of the concave trace the curved edges of the face-mould. The slide-line on a face-mould is always drawn at right angles to the level line.

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* The opposite sides of all the solids must be cut on parallel angles of inclination.

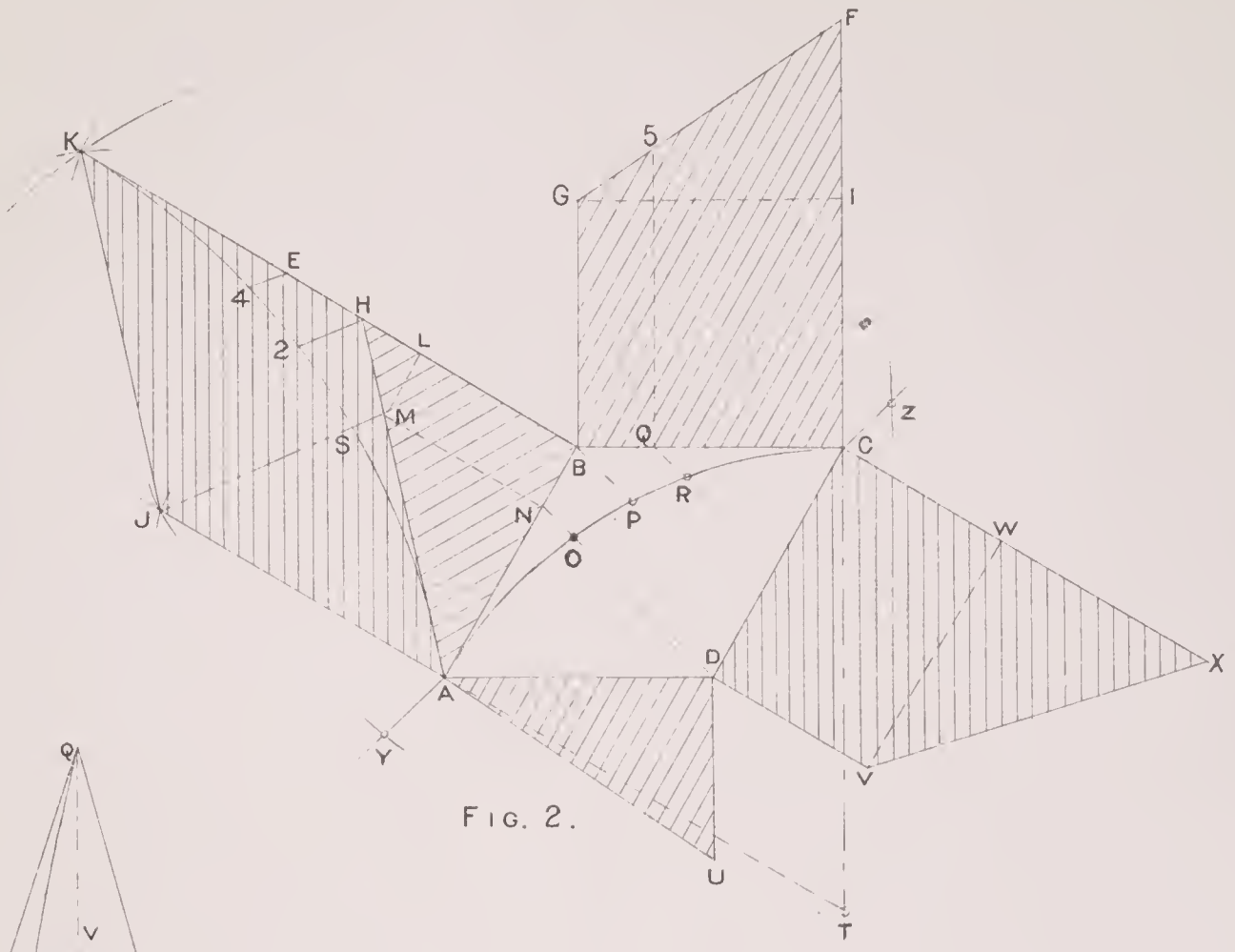

FIG. 2.

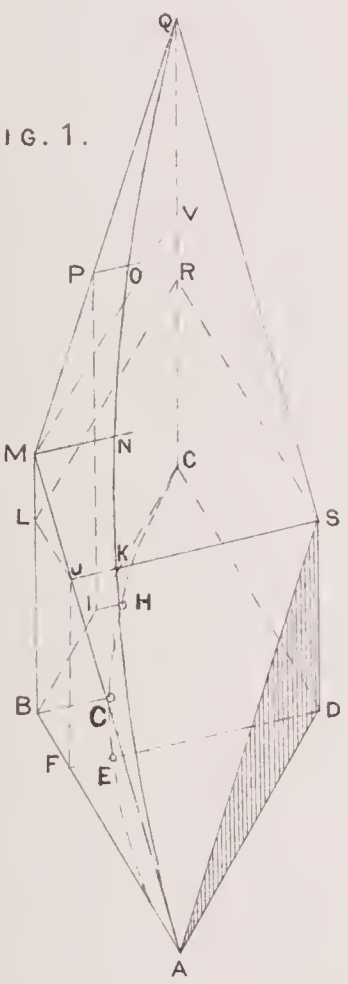

FIG. 1.

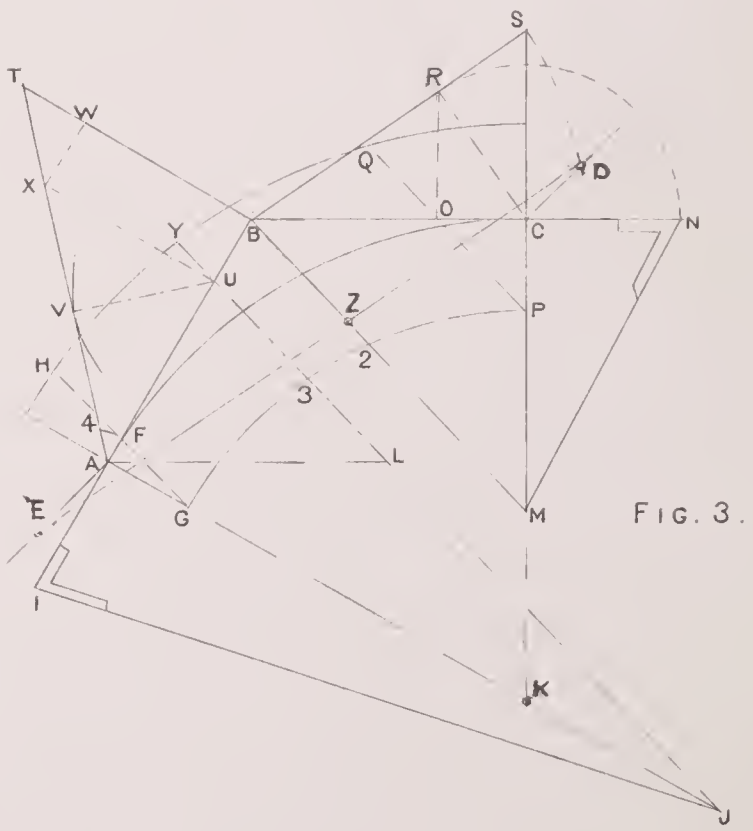

FIG. 3.

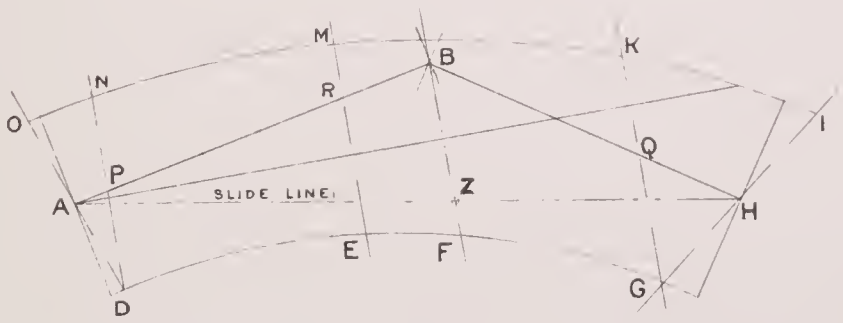

FIG. 4.

PLATE 17.

Fig. 1. Represents a Solid Block or Prism Standing Vertically on a Base of the Given Form A B C D, **the Parallel Sides of which are Equal, but Two of the Sides are Larger than the Other Two. The Upper End of the Solid is Shown as Cut on Two Different Angles: the Side** A B **on the Angle of Inclination** B J A, **and the Side** B C **on the Angle of Inclination** G F J.—On the base A Q P C represents a plan curve elliptic or eccentric, to which the sides of the solid A B and B C represent the plan tangents; and the lines A J and J F represent the tangents on the cutting plane. Make D K equal B J; draw K L parallel to A D; connect J L: then J L will be a level line on the cutting plane. Make L I parallel to E D; connect I B: then I B will be the direction of level lines on the horizontal plane common to both planes. At any point on the curve P draw P O parallel to I B; draw O H parallel to B J; make H M parallel to J L and equal to O P, and J N equal B Q; through A N M F trace a curve on the cutting plane which will lie perpendicularly over the plan curve A Q P C.

Fig. 2. Construction of a Paper Representation of a Solid with its Angles, Surfaces, and Curved Lines as Given in Perspective and Described at Fig. 1.—Let A B C D be the given form of base, and A H G C an eccentric or elliptic curve to which the sides A B and B C of the solid are tangent. At right angles to A B draw B U, C N and D M; at right angles to B C draw B E, C S and D L; let B U A be the angle of inclination required over the base or plan tangent A B; make B E and C R equal B U; let R S E be the angle of inclination required over the base or plan tangent B C; make D L, D M and C Q each equal R S; connect L A; make Q N equal B U; connect N M; make D K equal B U, draw J I parallel to D L, connect I B. At right angles to B I through C and A draw A P and C O indefinitely. On B as centre with E S as radius describe an arc at O; again on B as centre with U A as radius describe an arc at P: then P O will be the distance over A and C on the cutting plane. On U as centre with E S as radius describe an arc at X. On A as centre with P O as radius intersect the arc at X; on A with A J as radius describe an arc at V; and again on A with A L as radius describe an arc at W. On U as centre with B I as radius intersect the arc at V; connect A V W, W X, X U and U V; make U Y equal E T; parallel to U V draw Y 2; make Y 2 equal F G, and U Z equal B H; through A Z 2 X trace a curve on the cutting plane that will lie perpendicularly over the plan curve A H G C on the base. With a sharp-pointed instrument scratch the lines A B C D and A U; cut out the remainder of the figure and touch the adjoining edges with a little glue or thick mucilage and bring them together, leaving all lines on the outside so that their connections may be seen and understood.

Fig. 3. Plan of Hand-rail, an Eccentric or Elliptic Curve, the Tangents of Unequal Length and Two Different Angles of Inclination.—Let C P B and B Q A be the angles of inclination over the plan tangents C B and B A. Make A L parallel and equal to B C; make P M equal B Q; parallel to C B draw M F; parallel to C P draw F G; connect G L: then G L will be the direction of a level line common to both planes. Parallel to G L draw J K, E B W and U S; parallel to C P draw I N; parallel to B Q draw T 6. At right angles to G L through C and A draw C D and A H indefinitely. On B as centre describe the arc P D; again on B as centre with Q A as radius describe an arc at H; connect H D: then H D will be the distance on the cutting plane over A and C, and if lines are drawn from D and H to B, D B and H B will then be the length and angle of tangents on the cutting plane.

To Find the Angle for Squaring the Wreath-piece at the Joint over C:—Prolong the tangent B C to Z; prolong the joint-line C J until it meets the continuation of the level line G L at Y; make C Z equal M O; connect Z Y: then the bevel at Z will give a plumb-line on the butt-joint over C.

To Find the Angle for Squaring the Wreath-piece at the Joint over A:—Prolong the joint-line A U until it meets the continuation of the level line B 2 at W; prolong the tangent B A to X; make A X equal B R: then the bevel at X will give a plumb-line on the butt-joint over A.

Fig. 4. Face-mould over the Plan of Hand-rail Given and Described at Fig. 3.—Make A B equal H D of Fig. 3. Make B E equal D 5 of Fig. 3. On E as centre with 5 B of Fig. 3 as radius describe an arc at C; on B with B P of Fig. 3 intersect the arc at C, and if the work is correct A C will equal A Q of Fig. 3. Connect C E P, B C and A C; make B F K equal P N F of Fig. 3; make A M equal A 6 of Fig. 3; parallel to E C draw G F J, Q K, and N M L; make F J, F G equal I K, I J of Fig. 3; make K Q equal G 3 of Fig. 3; make C D, C P equal E B, B 2; make M N, M L equal T S, T U of Fig. 3; through A draw L O; make A O equal A L; through B draw G H; make B H equal B G; through H J D N O of the convex and G Q P L of the concave trace the curved edges of the face-mould. The joints A and B are at right angles to the tangents. The slide-line may be drawn anywhere on the face-mould, but must always be made at right angles to the level lines. It is a matter of convenience to draw the slide-line from the centre of either joint of the face-mould.

Fig. 5. To Find a Common Angle of Inclination Over Two Different Lengths of Plan Tangents when Required, the Total Height being Given:—The tangents are of the same length and angle as those of Fig. 3. Let C D equal both C P and C Q of Fig. 3. Prolong C B indefinitely; on B as centre with B A as radius describe the arc A F; connect D F; parallel to F D draw B E; parallel to C D draw B H; at right angles to A B draw B G; make B G equal B H; connect G A: then the angle of inclination B G A is the same as the angle C E B. In this case the angle for squaring the wreath-piece will be alike for both joints.

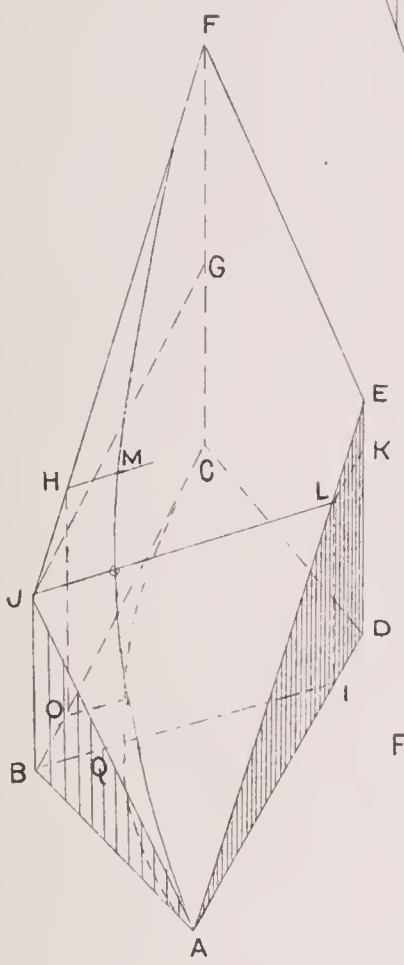

FIG. 1.

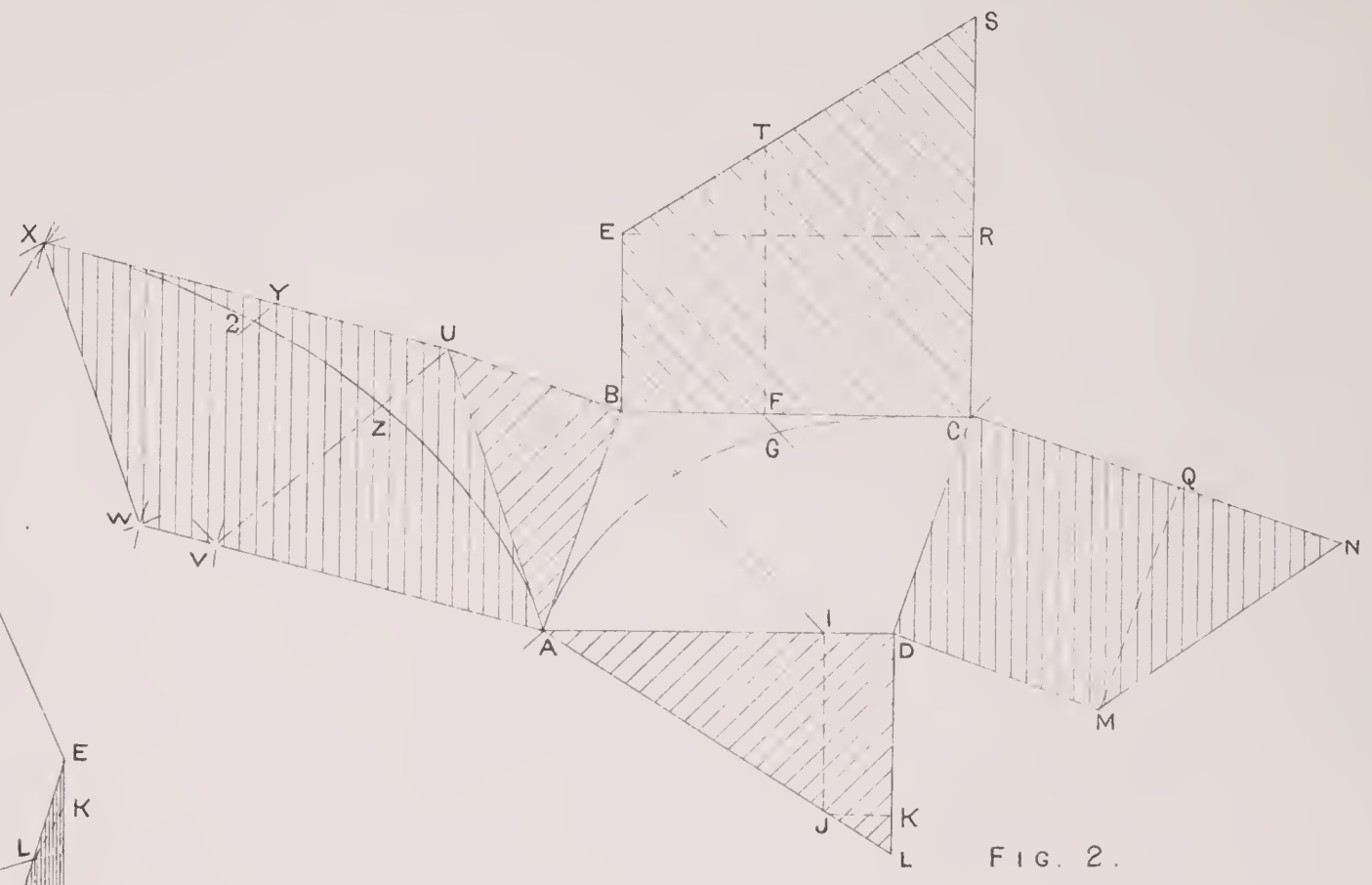

FIG. 2.

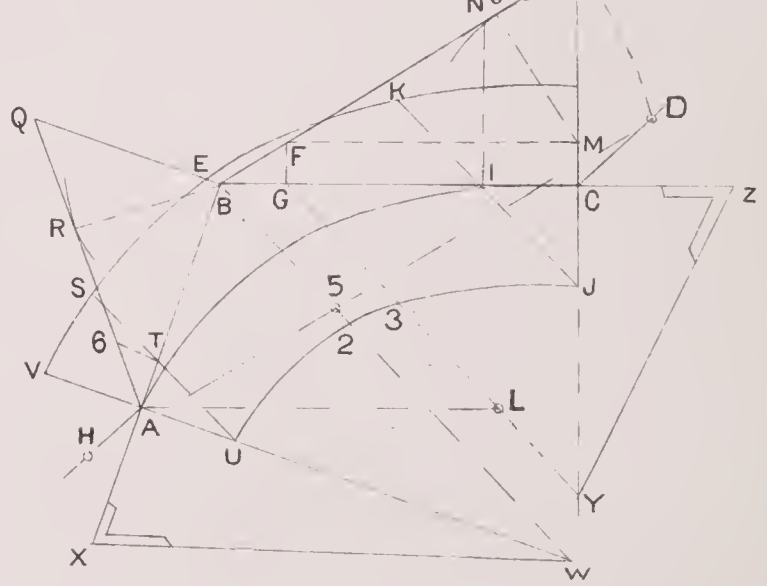

FIG. 3.

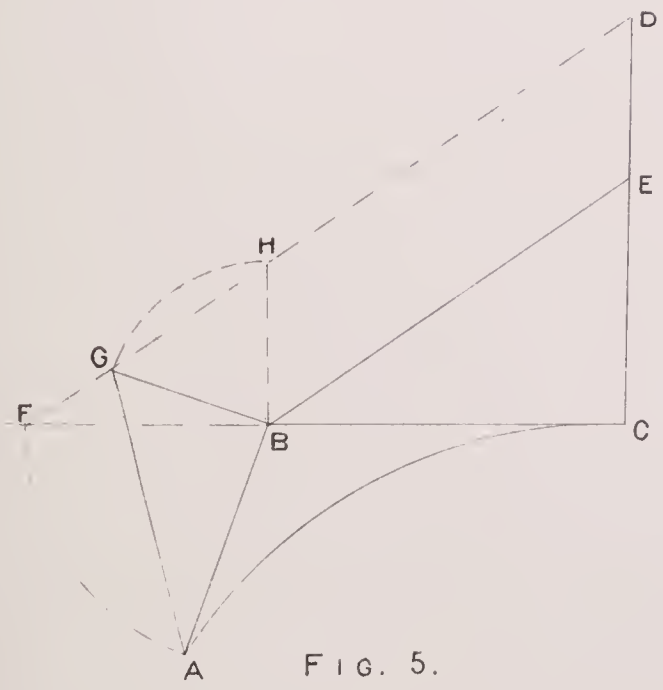

FIG. 5.

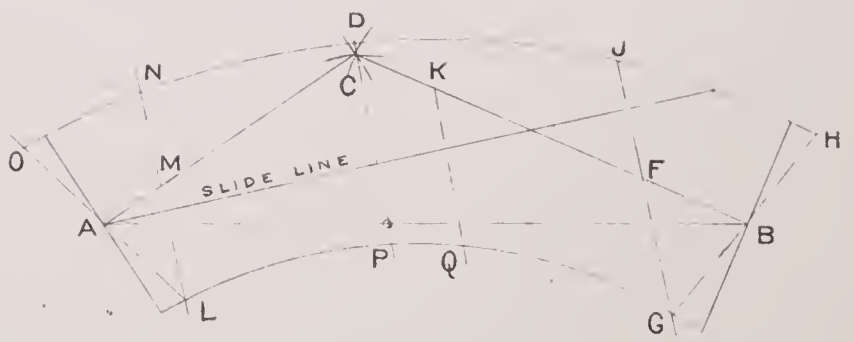

FIG. 4.

PLATE 18.

Fig. 1. Represents a Solid Block or Prism Standing Vertically on a Base of the Given Form A B C D, **the Sides of which are Equal and Parallel and have Two Acute and Two Obtuse Angles.**—The acute angle formed by the position of the sides A B, B C of the base is intended in this case to represent the angle of plan tangents, embracing in the plan a curve of more than a quarter-circle. The upper end of the solid is shown as cut on the side A B, on the angle of inclination B F A, and on the side B C, on the same angle of inclination M G F. The sides of this solid being cut on a common angle of inclination, the heights from the base D E and B F are alike, and therefore a line drawn on the cutting plane from F to E will be a level line; and at the base—or horizontal plane—a line drawn from D to B will be the position of a level line common to both planes. Over the base A B and B C the lines A F and F G represent the tangents on the cutting plane,—or those of a face-mould. At any points on the curve at the base parallel to B D draw Q R and L K; through R and K parallel to B F draw R I; parallel to F E draw I H and T N; make T N equal R Q. F J equal B O, and I H equal K L; through A N J H G trace a curve on the cutting plane which will lie perpendicularly over the plan curve A Q O L C.

Fig. 2. Construction of a Paper Representation of a Solid with its Angles, Surfaces, and Curved Lines as Given in Perspective and Described at Fig. 1.—Let A B C D be the form of base the opposite sides of which are parallel and equal. Draw A M and C M at right angles to B C and B A; on M as centre describe the plan curve A C, which is greater than a quarter-circle. At right angles to A B draw B U, C F and D I; at right angles to B C draw C G, B H and D X; let D X A and B U A be the common angles of inclination; make B H, C J, J G, C 4, 4 F and D I each equal B U; connect G H and F I. As D I and B H are of equal heights, a line from D to B will be the position of a level line common to both planes. Through C A draw the line P E indefinitely; on B as centre with U A as radius describe an arc at P and at E; then P E will be the distance over A and C on the cutting plane. At any points on the curve, as Q and R, parallel to M B draw Q O and L R; parallel to C G draw L K; parallel to B U draw O S. On U as centre with P E as radius describe an arc at V; on A as centre with A X as radius intersect the arc at V; again, on V as centre with the same radius describe an arc at W; on U with H G as radius intersect the arc at W; connect A V, V W, W U and U V; make U 2 equal H K; parallel to U V draw S T and 2 Z; make S T equal Q O, U Y equal B N, and 2 Z equal L R; through the points W Z Y T A trace a curve that will lie perpendicularly over the plan curve A Q N R C. With a sharp-pointed instrument scratch the lines A B C D A and A U; cut out the remainder of the figure and touch the adjoining edges with a little glue or thick mucilage and bring them together, leaving all lines on the outside, so that their connections may be seen and understood.

Fig. 3. Plan of Hand-rail Greater than a Quarter-circle; the Tangents to have a Common Angle of Inclination C F B **over the Tangent** C B, **and** B K A **over the Tangent** B A. Through A and C draw the line D E indefinitely; on B as centre with B F as radius describe the arc F E; and again on B with the same radius as before describe an arc at D: then D E will be the distance over A C on the cutting plane; and if lines are drawn from D to B and from E to B, then D B and E B will be the length and angle of tangents on the cutting plane. J B will be the direction of a level line common to both planes. Parallel to J B draw L O and C P; parallel to C F draw N G.

To Find the Angle for Squaring the Wreath-piece at Both Joints:—Prolong the tangent B C to H; make C H equal C G; connect H J: then the bevel at H will give a plumb-line on the butt joints over A and C.

Fig. 4. Face-mould over a Plan of Hand-rail Greater than a Quarter-circle, the Tangents having a Common Angle of Inclination as given at the Plan Fig. 3.—Let V X U equal D T E of Fig. 3. On V as centre with B F of Fig. 3 as radius describe an arc at W; and on U as centre with the same radius as before intersect the arc at W; connect V W, U W and X W: X W should equal T B of Fig. 3. Make V C and U G each equal F G of Fig. 3; parallel to W X draw V E, C B A, G H F and U K; make V E and U K each equal C P of Fig. 3. Make C B and C A equal N O and N L of Fig. 3; and again, make G H and G F equal N O and N L of Fig. 3. Through U draw F J indefinitely; through V draw A D indefinitely; make V D equal A V; make U J equal U F; make W Z Y equal B Q S of Fig. 3. The points V and U are at right angles to the tangents. Through D E B Z H K J of the convex and A Y F of the concave trace the curved edges of the face-mould.

Fig. 5. Parallel Pattern for Round Rail, or to be Used Instead of the Face-mould as a Means of Saving the Width of Stuff for Marking the Wreath-piece on the Rough Plank.—Make D T E equal D T E of Fig. 3; make E B and D B each equal F B of Fig. 3; connect B T, B D and B E; make E N and D N each equal F G of Fig. 3; make N M, N M each equal N M of Fig. 3; make B R equal B R of Fig. 3. Describe circles on the points E M R M D as centres of any required radius for width of pattern. Bend a flexible strip of wood or other material by which to mark curve-lines touching the circles for the convex and concave edges of the pattern. The joints are made at right angles to the tangents.

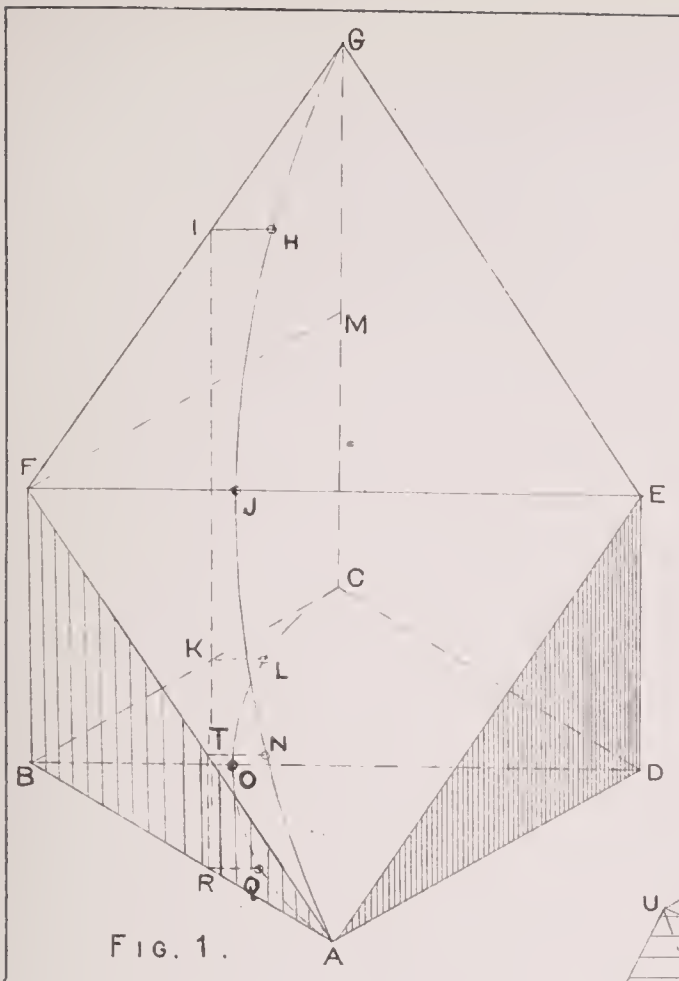

FIG. 1.

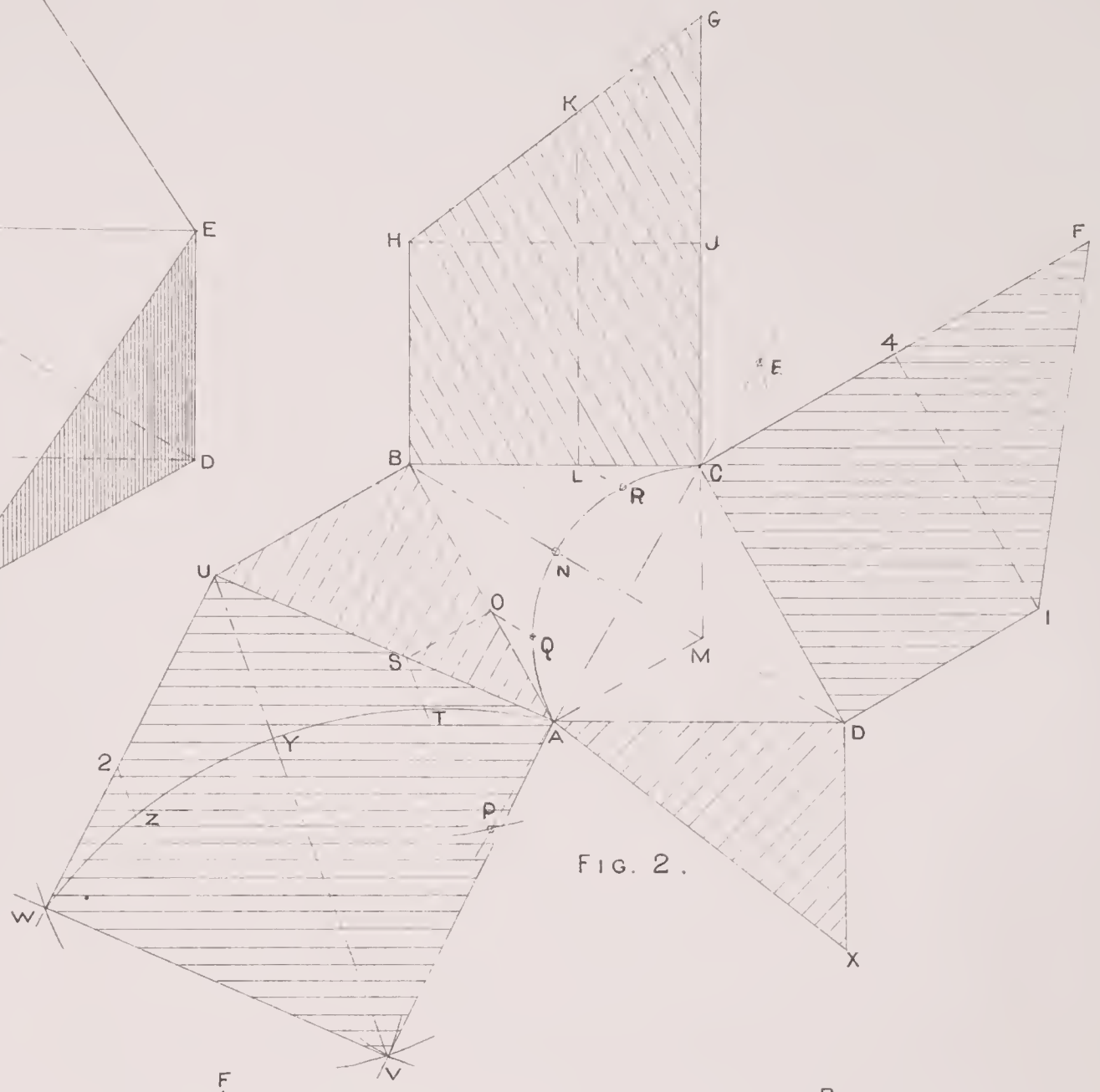

FIG. 2.

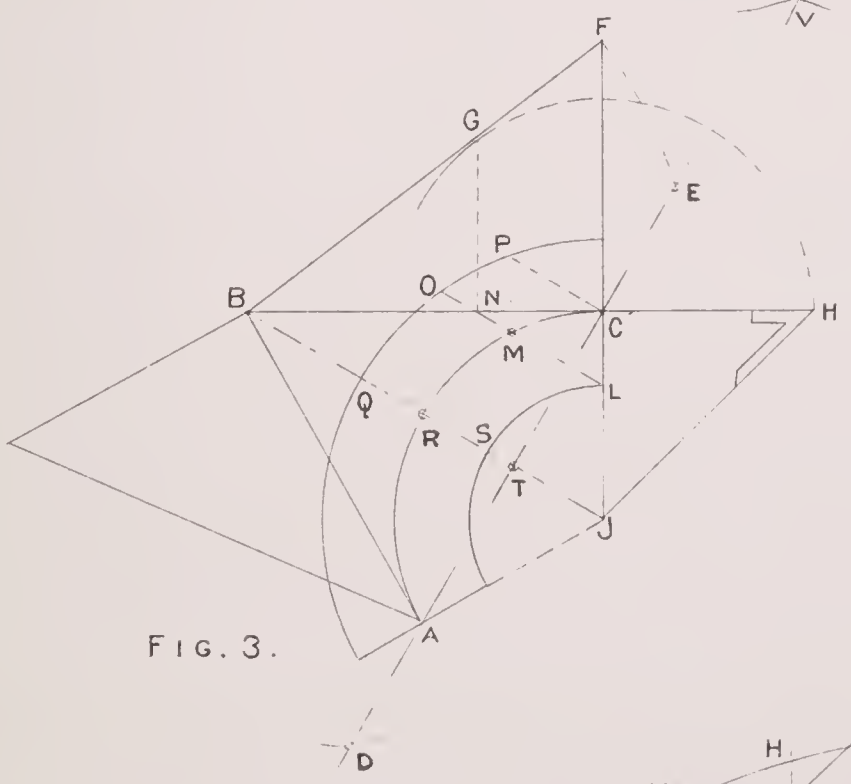

FIG. 3.

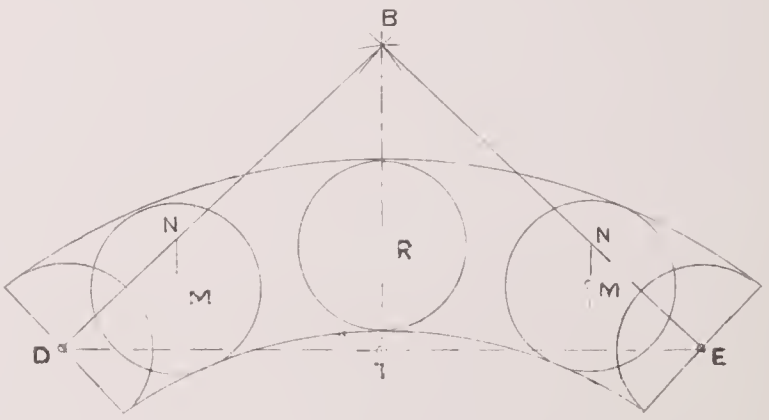

FIG. 5.

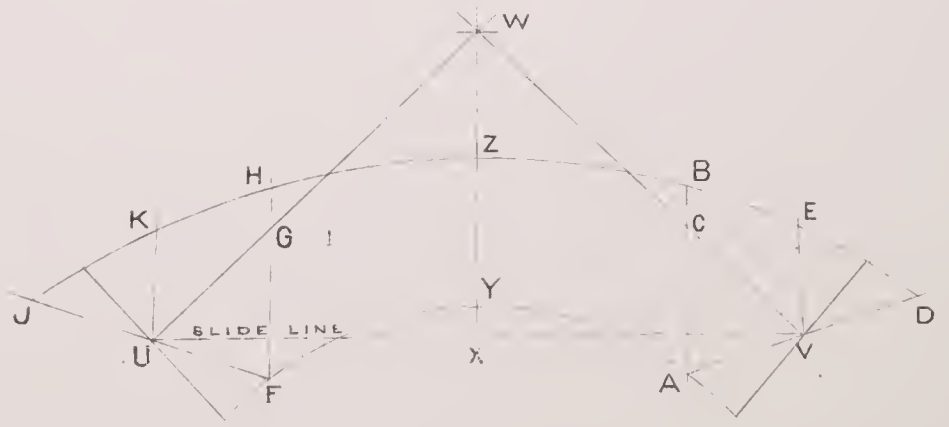

FIG. 4.

PLATE 19.

Fig. 1. Represents a Solid Block or Prism Standing Vertically on a Base of the Given Form A B C D, **the Sides of which are Equal and Parallel and have Two Acute and Two Obtuse Angles.**—The acute angle formed by the position of the sides A B, B C of the base is intended in this case to represent the angle of plan tangents embracing in the plan a curve of more than a quarter-circle. The upper end of the solid is shown as cut on the side A B on the angle of inclination B F A, and on the side B C on a less angle of inclination M G F.

To Find the Position of a Level Line on the Cutting Plane:—Make B N equal D E; draw N H parallel to A B; connect H E, which is the level line sought; parallel to B F draw H J: then *the line* D J *on the horizontal plane will be the position of a level line common to both planes.* At any points on the curve at the base parallel to J D draw O R and L K; through R and K parallel to B F draw R S and K U; parallel to H E draw U T and S P; make U T equal K L, S P equal R O, and H Q equal J X; through the points A P Q T G trace a curve on the cutting plane which will lie perpendicularly over the plan curve A O X L C.

Fig. 2. Construction of a Paper Representation of a Solid with its Angles, Surfaces, and Curved Lines as Given in Perspective and Described at Fig. 1.—Let A B C D be the form of base the opposite sides of which are parallel and equal. C X and A X are at right angles to A B and B C. On X as centre describe the plan curve A W C, which is greater than a quarter-circle. At right angles to A B draw B E, C L and D M; at right angles to B C draw B F, C H and D N; let B E A be the angle of inclination over B A; make B F and C J each equal B E; let J H F be an angle of inclination—over C B—less than B E A over B A; make D N, D M and C K each equal J H; make K L equal B E; connect L M and N A; make B 5 equal D N; draw 5 U parallel to B A, and U V parallel to E B: then a line drawn from V to D will be the position of a level line common to both planes. At right angles to D V draw A Q and C P; on B as centre with F H as radius describe an arc at P, and again on B as centre with E A as radius describe an arc at Q: then Q P will be the distance over A C on the cutting plane. At any points on the plan curve Y and J draw J I and Y O parallel to D V; make I G parallel to C H; make V U and O Z parallel to E B; on U as centre with V D as radius describe an arc at R; on A with A N as radius intersect the arc at R; on E as centre with F H as radius describe an arc at S; on A as centre with P Q as radius intersect the arc at S; connect A R, R S, S E and U R; make E T equal F G; parallel to U R draw Z 2 and T 4; make Z 2 equal O Y, U 3 equal V W, and T 4 equal I J; through the points S, 4, 3, 2 A trace a curve on the cutting plane that will lie perpendicularly over the plan curve A Y W J C. With a sharp-pointed instrument scratch the lines A B C D A and A E; cut out the remainder of the figure and touch the adjoining edges with a little glue or thick mucilage and bring them together, leaving all lines on the outside, so that their connections may be seen and understood.

Fig. 3. Plan of Hand-rail Greater than a Quarter-circle, the Tangents to have Two Different Angles of Inclination: B Z A **over the Plan Tangent** A B, **and a Less Angle of Inclination** C H B **over the Plan Tangent** C B.—Make A 4 parallel and equal to B C; make B 5 equal C H; draw 5 L parallel to A B, and L V parallel to Z B: then the line V 4 will be the direction of a level line common to both planes. Parallel to V 4 draw S U, B F and Q X; draw Y N parallel to Z B, and T J parallel to C H.

To Find the Angle for Squaring the Wreath-piece over the Joint C:—Prolong the tangent B C to G; make C G equal C D; connect G F: then the bevel at G will give a plumb-line on the butt-joint over C.

To Find the Angle for Squaring the Wreath-piece over the Joint A:—Make E R parallel to B A and equal to V M; connect R A: then the bevel at R will give a plumb-line on the butt-joint over A. Through C and A at right angles to V 4 draw C I and A K indefinitely; on B with B H as radius describe the arc H I; and again on B as centre with Z A as radius describe an arc at K; connect K I: then K I will be the distance over A and C on the cutting plane; and if lines are drawn from K to B, and I to B, then I B and K B will be the length and angle of tangents on the cutting plane or, which is the same thing, of the face-mould.

Fig. 4. Face-mould over a Plan of Hand-rail Greater than a Quarter-circle, the Tangents having Two Different Angles of Inclination as Given at the Plan Fig. 3.—Make H C A equal I O K of Fig. 3. On C as centre with O B of Fig. 3 as radius describe an arc at B; on H as centre with H B of Fig. 3 as radius intersect the arc at B: then if the work is correct A B will equal A Z of Fig. 3. Connect A B, B H and C B; make H N equal H J of Fig. 3; make B Q K equal Z L N of Fig. 3; parallel to C B draw N F, N O, Q L and K J, K D; make N O, N F equal T U, T S of Fig. 3; make Q R L equal V W P of Fig. 3; make K J, K D equal Y X, Y Q of Fig. 3; through A draw D E; make A E equal A D; through H draw F G; make H G equal H F. The joints H and A are at right angles to the tangents. Through G O R J E of the convex and F L D of the concave trace the curved edges of the face-mould. *The slide-line in this case and of all face-moulds of whatever character is always at right angles to the level line.*

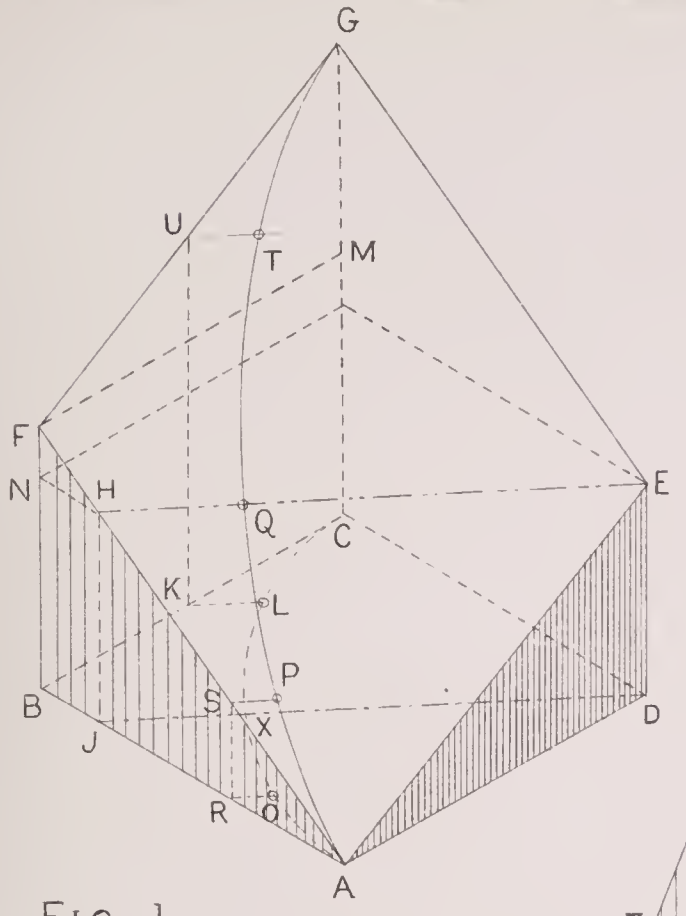

FIG. 1.

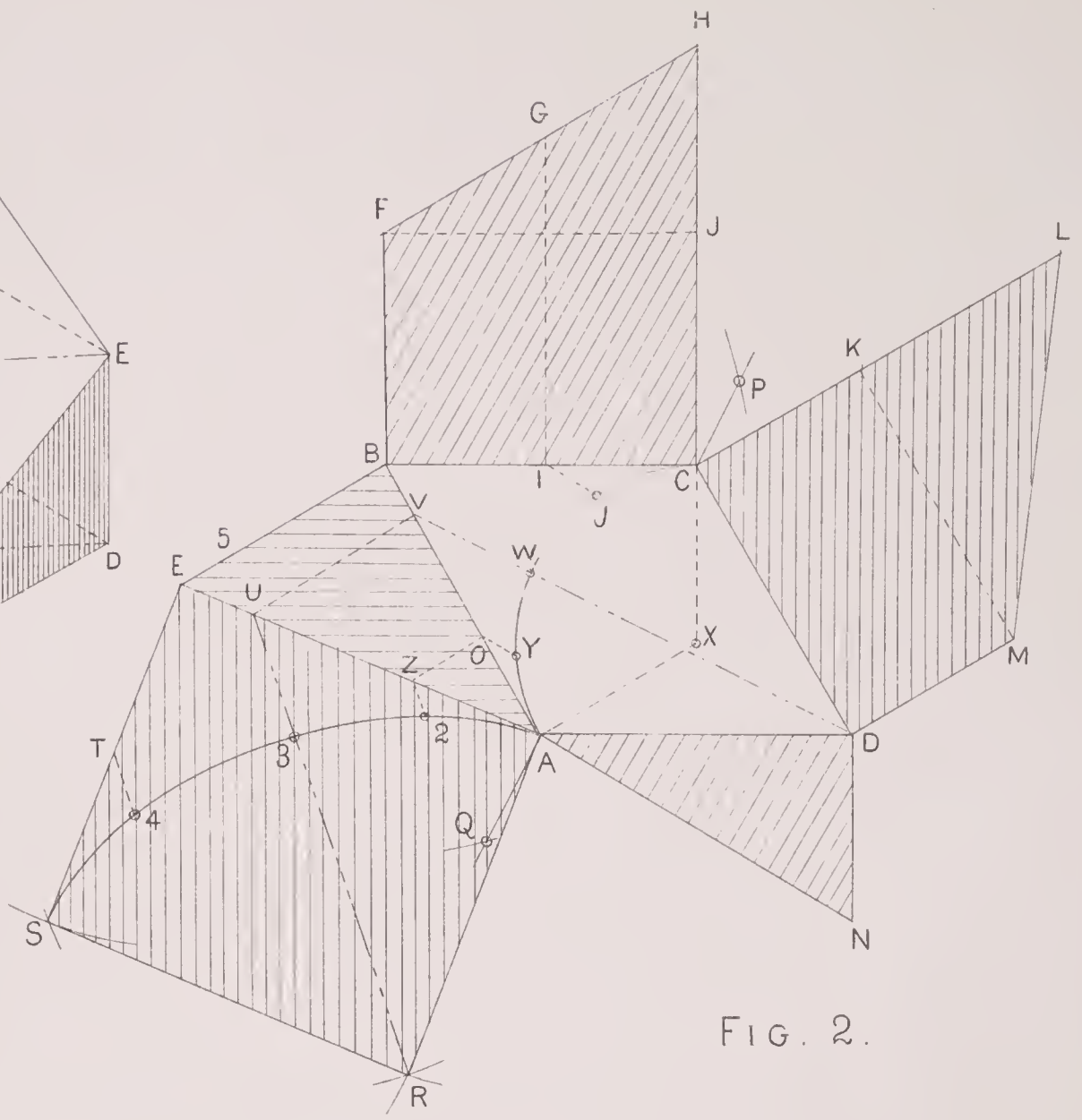

FIG. 2.

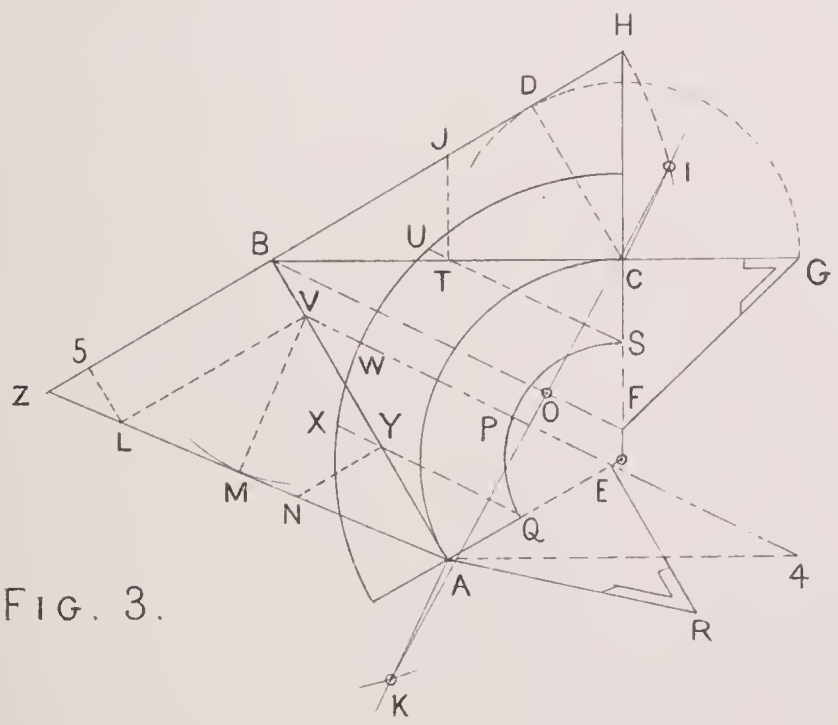

FIG. 3.

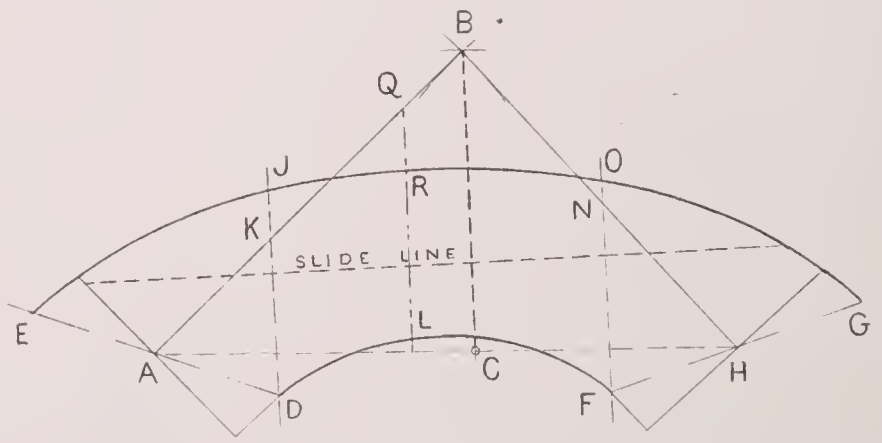

FIG. 4.

PLATE 20.

Skilful workers of hand-rail know that carefully shaping the wood next the joints of a wreath-piece so that it will nicely fall in with its adjoining pieces, of whatever character they may be, is of the first importance; next, experience has taught them that the interval—the helical surfaces—or top and bottom surfaces between joints, compel them to follow certain curvatures peculiar to each kind of wreath-piece. From these facts of experience it is evident that a face-mould is not only a means of shaping the sides of a wreath on the plane of the plank, but that it carries with it certain geometrical curves that shape the top and bottom surfaces of the wreath. This controlling curve-line of helical surfaces of wreaths is a centre line,* as at A E R, FIG. 2, and is found in the development of the central cylindric line on cutting planes as Z J U of FIG. 1, PLATE No. 11, and C O Q S E of FIG. 1, PLATE No. 10. See also the similar cases of the two last solids referred to, with their cutting planes brought in position over the plan at their bases, FIG. 6, PLATE No. 11. A round hand-rail—controlled from its centre as it properly must be—over a circular or curved plan affords a complete demonstration that this centre cylindric line gives shape to the top and bottom of the rail, for while its curved sides hang vertically over the plan, its top and bottom also take proper curves, forming its own easings perfectly suited to the requirements of every case. To measure and make an exact drawing of this centre line will demonstrate the peculiar form of curvature in all cases of wreaths, and also show exact heights at every point over an elevation of treads and rises embraced within any curved plan. Thus the practical use of developing the centre line will be to get the length of balusters in any position as required on winding steps in cylinders; also the ability to test the wreath-piece over the elevation, and determine when desirable what changes to make, if any, in the inclination of tangents.

Fig. 1. The Semicircle A C M is a Plan of the Centre Line of a Hand-rail with Tangents to Each Quarter A B, B C and C N, N M.—In this plan the two quarters that make the semicircle are of the same character as the first two solids introduced. The first solid at PLATE No. 10 is here repeated by D M N C; the other, D A B C, at PLATE No. 11. At PLATE No. 11, FIG. 6, two similar solids are brought together showing the difference in their cutting planes as placed in position over the plan of a semicircle at the base. The quarter-circle A C over its tangents A B, B C has a common inclination B Y A, C E B; also the quarter-circle M C over one tangent C N has the same inclination N R C, while the tangent M N remains level. On the quarter A C, B D is the position of a level line common to both planes, as before shown; and on the quarter C M, N M is the level line common to both planes. Divide the quarter-circle A C, and the quarter C M, each into four equal parts; through L and H draw L J, H G parallel to the level line D B; parallel to C E draw G F; parallel to B Y draw J K; through O, P, Q parallel to the level line M N draw O S, P T and Q U.

Fig. 2. Development or Unfolding of the Centre Line of a Semicircular Wreath of Hand-rail over the Plan A C M as given at Fig. 1.—Draw A X; make A L I equal A L I of FIG. 1. Draw I Y at right angles to A X; make I Y and L K equal J K and B Y of FIG. 1. Parallel to A X draw Y C; make Y H C equal I H C of FIG. 1; draw C E and H F at right angles to A X; make H F and C E equal G F and C E of FIG. 1. Parallel to A X draw E N; make E Q P O N equal C Q P O M of FIG. 1. Through N at right angles to A X draw X R; make N R, O S, P T and Q U at right angles to E N and equal to N R, V S, W T and X U of FIG. 1. Through the points A K Y F E U T S R trace the centre line sought.†

Fig. 3. The Semicircle Q V S is the Plan of a Centre Line of Hand-rail with Tangents to each Quarter Q U, U V and V W, W S.—Let U T Q be the inclination required over the plan tangent Q U, and V Y U the greater inclination required over the plan tangent U V; and for the quarter S V the angle W A V must be the same as V Y U; the plan tangent W S remains level. To find the level line for the quarter Q V, let Y X equal U T; draw X Z parallel to V U, and Z F parallel to Y V; connect F R, which is the level line sought. Divide V J in two parts; parallel to F R draw U K; divide K Q into three parts; divide V S into four parts; parallel to the level line S W draw P B, O C and N D; parallel to R F draw H G, L 8 and M 6; parallel to V Y draw G E; parallel to U T draw 8, 4 and 6, 5. *See* PLATE No. 12 *for case of solid like* R Q U V of FIG. 3.

Fig. 4. Development of the Centre Line of a Semicircular Wreath of Hand-rail over the Plan Q V S as given at Fig. 3.—On the line Q F make Q M L K equal Q M L K of FIG. 3. Erect the perpendiculars K T, L 4 and M 5 equal to U T, 8, 4 and 6, 5 of FIG. 3. Draw T V parallel to Q F; make T J H V equal K J H V of FIG. 3; perpendicular to Q F draw V Y, H E and J Z; make V Y, H E and J Z equal V Y, G E and F Z of FIG. 3; parallel to Q F draw Y W; make Y N O P W equal V N O P S of FIG. 3; through W at right angles to Q F draw F A; make W A, P B, O C and N D equal W A, 3 B, 2 C and I D of FIG. 3. Through the points Q 5 4 T Z E Y D C B A trace the centre line sought.

Fig. 5. This Portion of a Circle Less than a Quarter is a Plan of a Centre Line of Hand-rail with its Tangents D C and C B.—Over the plan tangent D C let D E C be the angle of inclination required, the tangent C B to remain level. Divide the curved line B D into any number of equal parts, and from the points of division J I H G F draw lines parallel to B C and touching D C; at right angles to D C draw O P, N Q, M R, L S and K T.

Fig 6. Development of the Centre Line of a Wreath-piece over a Plan of a Portion of a Circle less than a Quarter as given at Fig. 5.—On the line D B make D F G H I J B equal the spaces between the corresponding letters at FIG. 5. Make D E, F T, G S, H R, I Q and J P equal D E, K T, L S, M R, N Q and O P of FIG. 5. Through the points B P Q R S T E trace the centre line sought. *The solid* FIG. 5 *is given in detail at* PLATE No. 13.

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* The tangents are invariably placed at the centre of the width, and the heights and angles of inclination are also always at the centre of the thickness of the wreath-piece.

† A practical self-imposed useful lesson would be to make the two solids composing FIG. 1 of wood, and gluing them together in the manner shown at FIG. 6, PLATE No. 11, remove the wood to the semicircle at the base and its vertical trace on the cutting planes; then wrap FIG. 2, the development, around the cylindric surface of FIG. 1, and test the curve thus obtained.

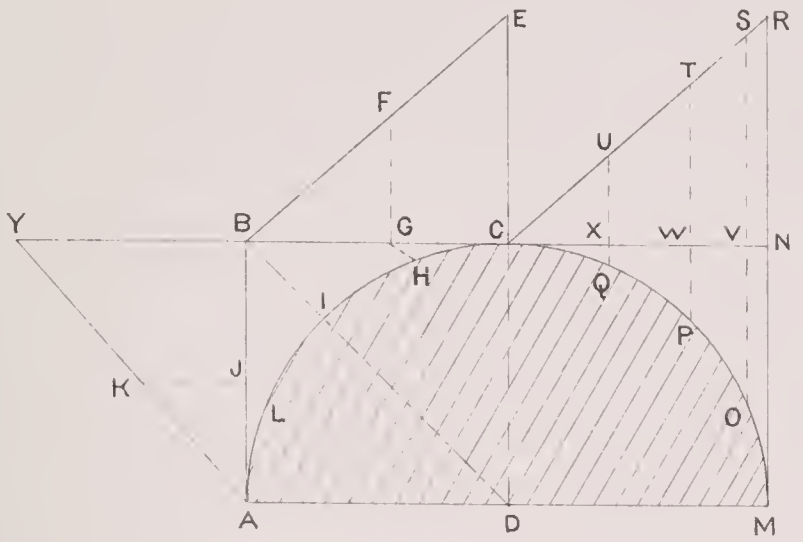

FIG. 1.

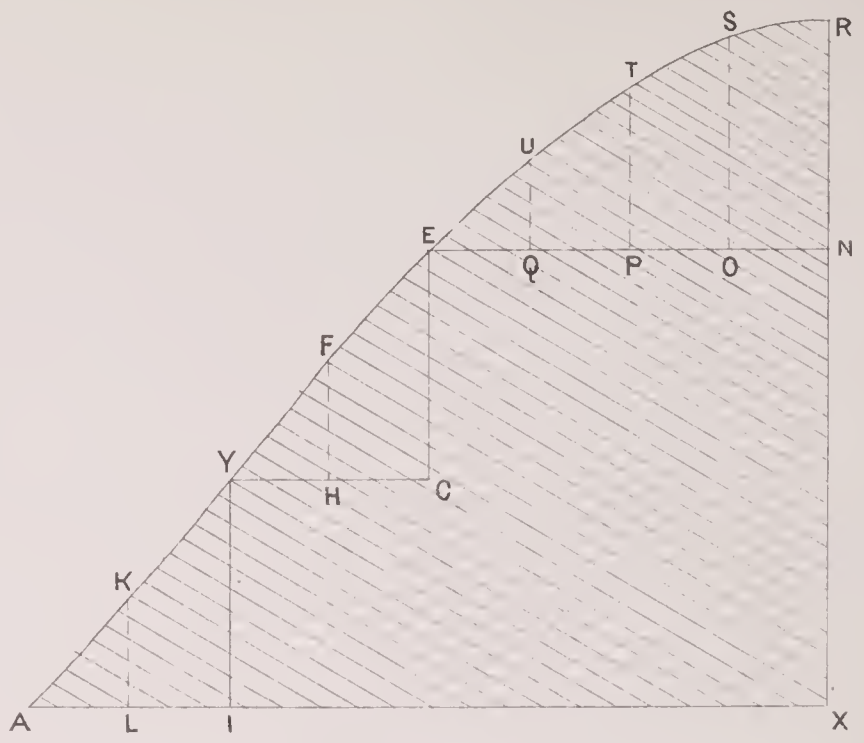

FIG. 2.

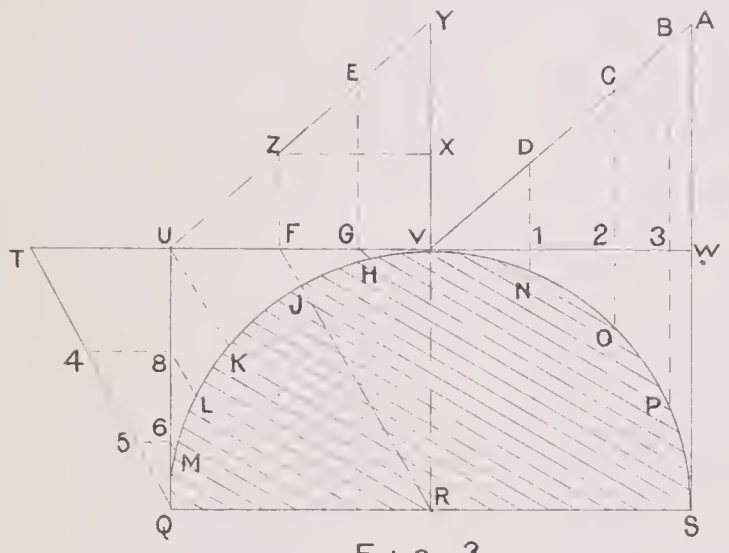

FIG. 3.

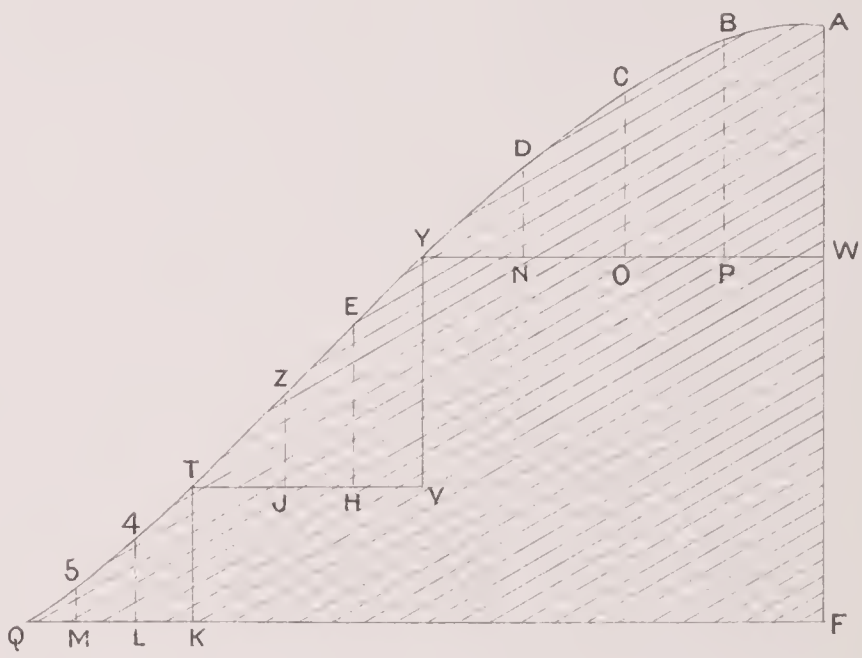

FIG. 4.

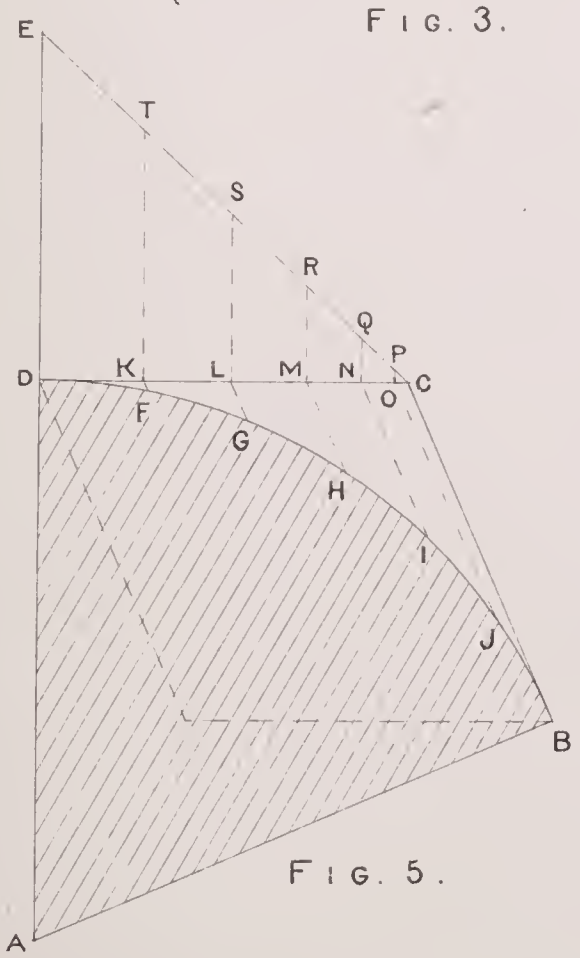

FIG. 5.

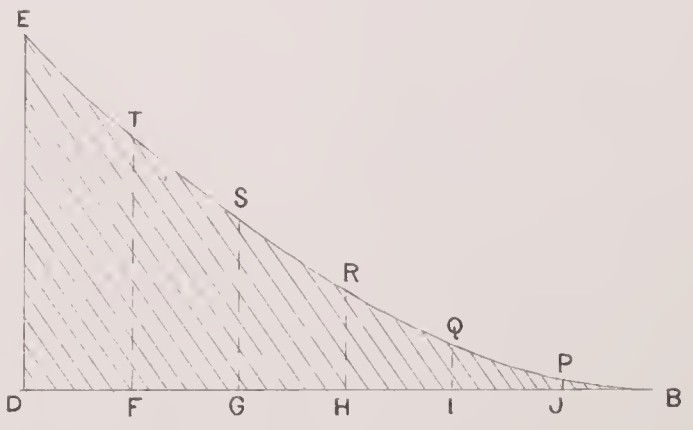

FIG. 6.

PLATE 21.

Fig. 1. Plan of a Centre Line of Hand-rail Greater than a Quarter-circle; the Tangent B C to have an Angle of Inclination Equal to C D B, the Other Tangent B A to Remain Level.—Divide the circular line A C into any number of equal parts, and from each of these points of division draw lines parallel to the level line A B touching the tangent B C, as O V, E F, G H, L K and M N; parallel to C D draw N P, K J, H I, F S and V W. *This solid is given at* PLATE No. 14.

Fig. 2. Development or Unfolding of the Centre Line of a Wreath-piece over a Plan Greater than a Quarter-circle as given at Fig. 1.—On the line A C make A O E G L M C equal the spaces between the corresponding letters of FIG. 1. At right angles to A C draw C D equal to C D of FIG. 1. Make M P, L J, G I, E S and O W parallel to C D and equal to N P, K J, H I, F S and V W of FIG. 1. Through A W S I J P D trace the centre line sought.

Fig. 3. Plan of a Centre Line of Hand-rail Greater than a Quarter-circle, the Tangents Q T and T X to have the Common Angle of Inclination X Y T and T Z Q.—Divide the circular line Q X into any even number of equal parts, and from each of these points of division draw lines parallel to the level line R T touching the tangents, as I J, G H, D E and A B; make J K and H L parallel to X Y, and E M and B C parallel to T Z. *This solid is given at* PLATE No. 18.

Fig. 4. Development of the Centre Line of a Wreath-piece over a Plan Greater than a Quarter-circle as given at Fig. 3.—On the line Q P let Q A D F equal the spaces between the corresponding letters of FIG. 3. At right angles to Q F draw F Z, D M and A C equal to T Z, E M and B C of FIG. 3. Make Z X parallel to Q P; make Z G I X equal F G I X of FIG. 3; through X draw Y P at right angles to Q P; make I K and G L parallel to X Y; make X Y, I K and G L equal X Y, J K and H L of FIG. 3; through Q C M Z L K Y trace the curve sought.

Fig. 5. Plan of a Centre Line of Hand-rail Greater than a Quarter-circle, the Tangents to have Different Angles of Inclination; the Angle D C F over the Plan Tangent D F, and a Less Angle of Inclination F E A over the Plan Tangent A F.—To find a level line common to both planes: draw A B parallel and equal to F D; make C L equal F E; draw L J parallel to D F; make J I parallel to D C: then *the line* I B *will be the level line sought.* From F draw F P parallel to I B; divide P A and O D each in two equal parts; draw Q H and N M parallel to I B; make M K parallel to D C, and H G parallel to F E. *This solid is given at* PLATE No. 19.

Fig. 6. Development of the Centre Line of a Wreath-piece over a Plan of More than a Quarter-circle, the Tangents having Different Angles of Inclination as given at Fig. 5.—On the line A R make A Q P equal A Q P of FIG. 5; make P E and Q G perpendicular to A R and equal to F E and H G of FIG. 5; draw E D parallel to A R; make E O N D equal P O N D of FIG. 5; through D draw C R at right angles to A R; draw N K and O J parallel to D C; make D C, N K and O J equal D C, M K and I J of FIG. 5; through the points A G E J K C trace the centre-line sought.

Fig. 7. Plan of a Centre Line of Hand-rail Less than a Quarter-circle, the Tangents S U and U V to have the Common Angle of Inclination V X U and U W S.—Make S T parallel and equal to U V: then T U will be a level line common to both planes. Divide the curved line S V into any even number of equal parts S A D K G Y V; parallel to T U draw Y Z, G H, D E and A B; parallel to V X draw Z J and H I; make E F and B C parallel to U W. *This solid is given at* PLATE No. 15.

Fig. 8. Development of the Centre Line of a Wreath-piece over a Plan of Less than a Quarter-circle, the Tangents having a Common Angle of Inclination as given at Fig. 7.—On the line S L make S A D K equal S A D K of FIG. 7; at right angles to S L make K W, D F and A C equal U W E F and B C of FIG. 7; draw W V parallel to S L; make W G Y V equal K G Y V of FIG. 7; through V at right angles to S L draw X L; parallel to L X draw Y J and G I; make V X, Y J and G I equal V X, Z J and H I of FIG. 7; through the points S C F W I J X trace the centre line sought.

Fig. 9. Plan of a Centre Line of Hand-rail Less than a Quarter-circle, the Tangents to have Different Angles of Inclination; P R M over the Tangent, M P and N Q P a Less Angle of Inclination over the Tangent P N.—Make P S equal N Q, and S T parallel to P M; make T V parallel to R P; from M parallel and equal to P N draw M O: then O V will be a level line common to both planes. Divide B M in two equal parts M A B; draw P C parallel to V O; divide C N into three equal parts C D E N; parallel to O V draw E F, D G and A U; parallel to N Q draw F I and G H; parallel to P R draw U J. *This solid is given at* PLATE No. 16.

Fig. 10. Development of the Centre Line of a Wreath-piece over a Plan of Less than a Quarter-circle, the Tangents having Different Angles of Inclination as given at Fig. 9.—On the line M F make M A B C equal M A B C of FIG. 9; at right angles to M F make C R, B T and A J equal P R, V T and U J of FIG. 9; draw R N parallel to M F; make R D E N equal C D E N of FIG. 9; through N draw F Q at right angles to M F; parallel to N Q draw E I and D H; make N Q, E I and D H equal N Q, F I and G H of FIG. 9; through the points M J T R H I Q trace the centre line sought.

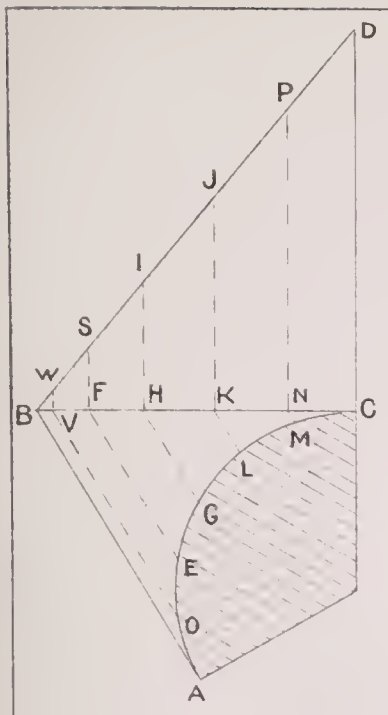

FIG. 1.

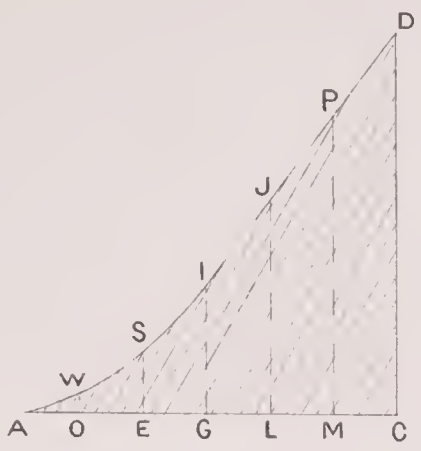

FIG. 2.

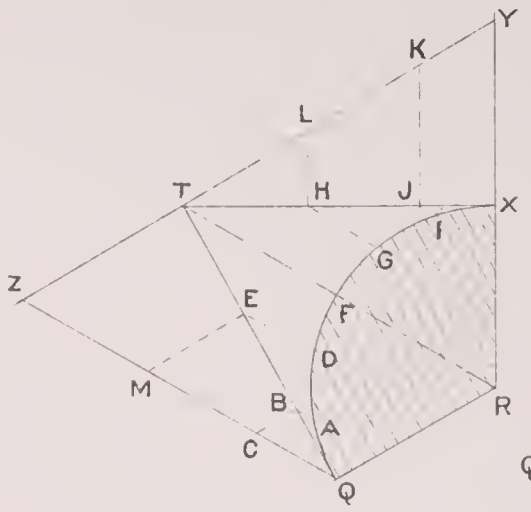

FIG. 3.

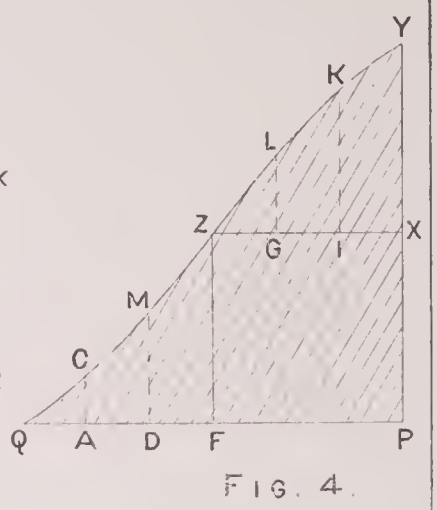

FIG. 4.

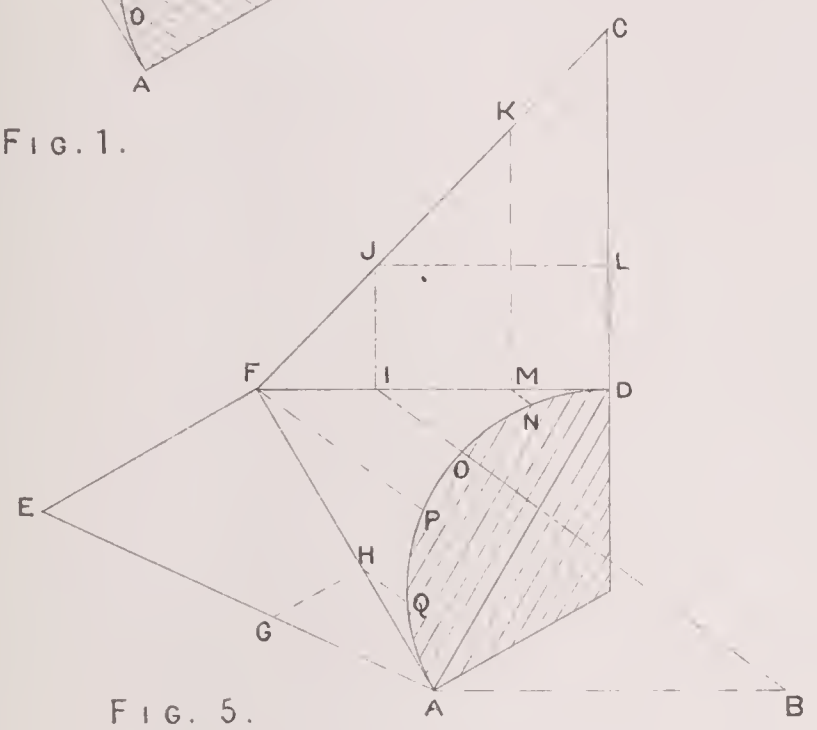

FIG. 5.

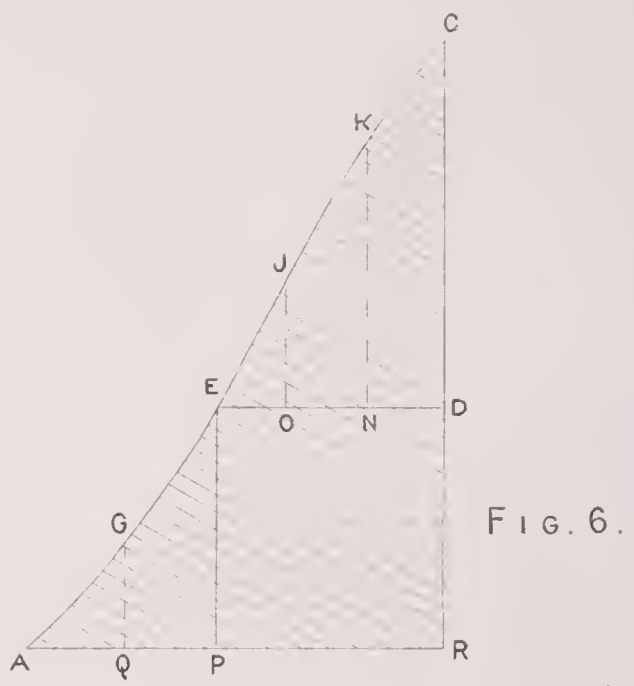

FIG. 6.

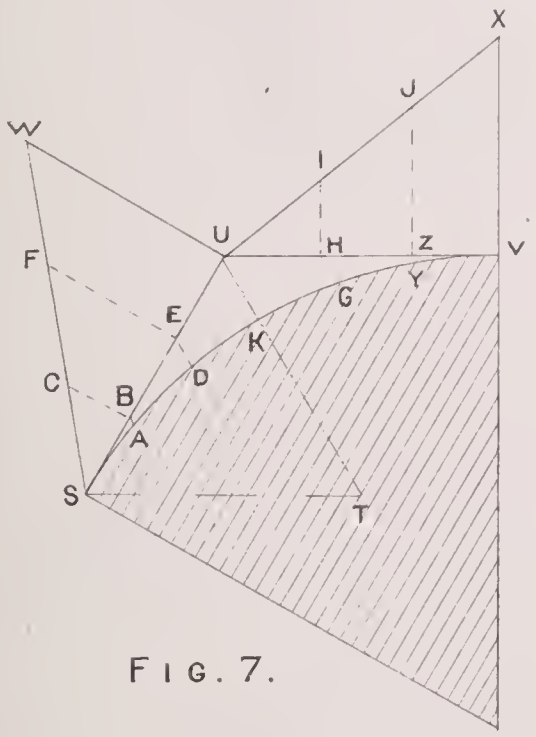

FIG. 7.

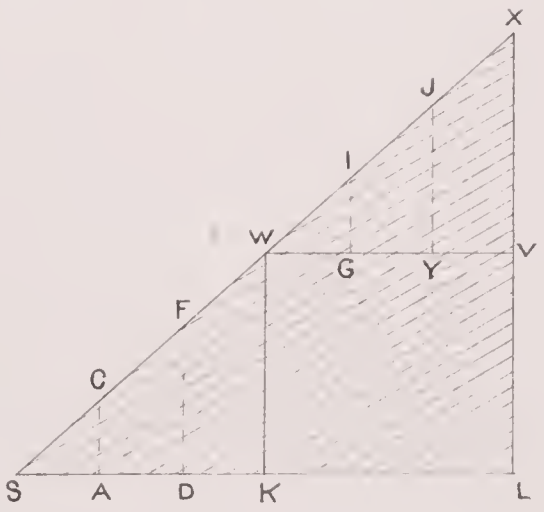

FIG. 8.

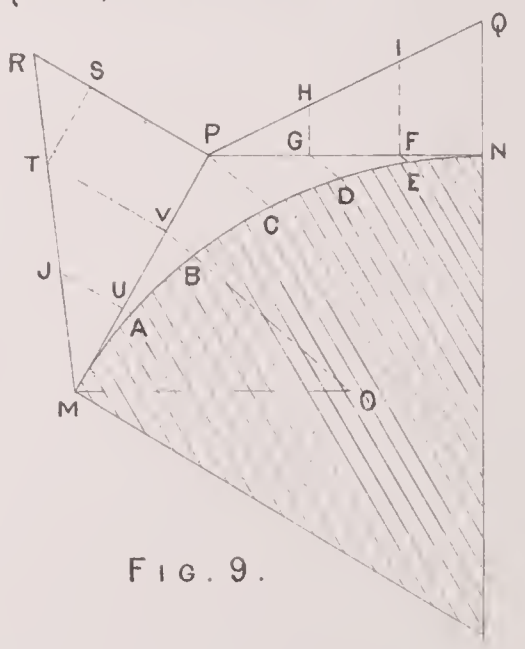

FIG. 9.

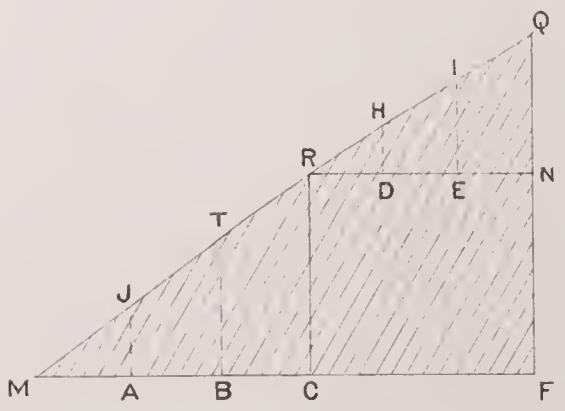

FIG. 10.

PLATE 22.

POSITION OF RISER IN CONNECTION WITH CYLINDERS AT THE LANDING AND STARTING OF STRAIGHT FLIGHTS OF STAIRS.—THE FACE-MOULD, AND THE MANAGEMENT OF THE WREATH-PIECES.

Fig. 1. A Sufficient Elevation of Rises and Tread to Determine the Place of Riser at the Bottom of a Flight when the Over-wood is to be all Removed from the Top of the Wreath-piece, as in this Case.—Let X X be the centre of the short balusters and the bottom line of the hand-rail; make X B the thickness of rail, and X C = $3\frac{1}{2}''$ the thickness of plank; draw C E parallel to X X; make X A half the thickness of plank; draw A D parallel to X X; make N F four inches, and F D half the thickness of the rail, $1\frac{1}{8}''$, being all together, from the floor to S, $5\frac{1}{8}''$. Where the centre line A D intersects the centre level line S D, that intersection at D fixes the centre of wreath-piece as shown. From D parallel to the riser draw D G indefinitely; anywhere below the floor-line and parallel to it draw K G; as G is the centre of the rail, G O must be a half-inch to the face of the cylinder; and as the diameter of the cylinder is 6″, O K must be 3″; draw K L parallel to the riser; continue the line of the first riser to H; on K with K O for radius describe the cylinder: then H J shows the distance to be $1\frac{1}{2}''$ between the bottom riser and the commencement of the cylinder; and this is so placed at the plan FIG. 3, as may be seen by the corresponding letters.

Fig. 2. Elevation of Tread and Rise at the Top of a Flight Sufficient to Determine, when all the Over-wood is Removed from the Bottom of a Wreath-piece, the Relative Position of the Riser and Cylinder.—At the bottom—FIG. 1—all the over-wood, B C, is taken off the top of the straight part of the wreath-piece; not, however, because it is the top, but because it is the concave face; and in cases of this kind it makes the best shape either for the top or the bottom of the flight. At the top of the flight this over-wood is taken off at the bottom side of the wreath-piece. This is so because the bottom wreath-piece is simply turned the other side up at the top of the flight, but the over-wood is still taken from the concave face. The position of the cylinders differ; at the bottom of the flight the chord-line of the cylinder is $1\frac{1}{2}''$ from the face of the riser, and at the top of the flight it is 2″. The letters at the various points of this elevation are made to correspond with those of FIG. 1, so that having examined and made the drawings of that figure, a careful inspection of this will be all the explanation needed.

Fig. 3. Plan of the Bottom of Flight with the Riser and Cylinder as Determined at Fig. 1.

Fig. 4. Plan of the Top Portion of Flight with the Cylinder and Riser Placed as Determined by the Trial at Fig. 2.—Of the plan of hand-rail around the cylinder, one quarter-circle has to be prepared for drawing a face-mould. Q X and X G are the plan tangents to the centre line of rail, the pitch-board to be placed as shown; continue G X to W; parallel to G X draw A V, Z T and K Y R.

Fig. 5. Face-mould.—* Draw F W indefinitely; make W V T R equal W V T R of FIG. 4. At right angles to F W draw W B, V A, T O Z and R E Y; make W B equal X G of FIG. 4. Through B draw A D parallel to R W; make B D equal B A; make B C equal G C of FIG. 4; make T O, T Z, R E, R Y each equal S O, S Z and Q Y, Q Y of FIG. 4; parallel to R F draw Y M and E L; through D C O E of the convex and A Z Y of the concave trace the curved edges of the face-mould. In this connection is shown the laying out of joints B and F to square the wreath-piece.

Fig. 6. Perspective Sketch of the Wreath-piece, showing both joints prepared for squaring, and the application of the face-mould to both sides of the stuff.

Fig. 7. Elevation of Tread and Rises for the Top and Bottom as before Given, the Object being to show that sometimes by a Change in Removing the Over-wood the Wreath-piece may be Kept in its Required Position as to Height and the Chord-line of the Cylinder Brought to the Face of the Riser.—G is the centre of the rail, G O is $\frac{1}{2}''$; O K is the radius of the cylinder. The height from the floor to D is fixed as before, alike at the bottom and at the top. The bottom line of rail must pass through X X, the centres of the short balusters; from X X set off the thickness of rail $2\frac{1}{4}''$; and from D, which must be at the centre of the plank, set off both ways half the thickness of plank parallel to X X: this will show how the over-wood must be removed from the straight part of each wreath-piece.† *The bottom of the rail at the centre of the wreath is kept* 4″ *above the floor to suit the required length of balusters on the level.* At X X the short balusters are 2′.2″ from the top of the step to the bottom of the rail; then from the floor to the bottom of the level rail the height will be 4″ more, equal to 2′.6″, the same length that the longest baluster on each step has to be, because being half a tread back from the short baluster, it must therefore be a half-rise longer. The merchantable lengths of ordinary balusters are 2′.4″ and 2′.8″, thus allowing one inch to go in the rail and one inch to dovetail in the step. *The illustrations given at* FIGS. 1, 2 *and* 7 *as methods of working wreath-pieces and disposing of the over-wood on the straight part are not to be understood as applying only to* 6″ *cylinders;* for after fixing the required position of wreath-piece, and G and O, then O K may be any radius of cylinder, more or less. For instance, in the case of FIG. 1, if O K, instead of being a radius of 3″, should be 6″, then the riser would set $1\frac{1}{2}''$ into the 12″ cylinder. And again, if instead of O K being 3″, it should be 2″ radius, then there would be $2\frac{1}{2}''$ straight between the riser and the chord-line of a 4″ cylinder.

NOTE.—It must be understood that throughout this work, with the exception of the cases given at PLATES 34 and 35, all joints of wreath-pieces are to be made at right angles to their tangents, and square through the face of the plank.

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* At PLATE No. 10 are given perspective and geometrical drawings, and the formation of a paper representation of a solid, a plan of hand-rail, and from it a drawing of a face-mould, which together give a complete practical knowledge of the application and drawing of face-moulds of this kind.

† At FIG. 7 about all that can be done further—if desirable—within the limits of the thickness of the plank will be at the top of the flight to take all the over-wood off the top of the wreath-piece, and at the bottom of the flight take all the over-wood off the bottom of the wreath-piece; this change would bring D at the bottom of the flight—keeping it at the same height about $\frac{1}{2}''$ nearer to the riser; and D at the top, about $\frac{1}{4}''$ nearer to the riser, at the same height.

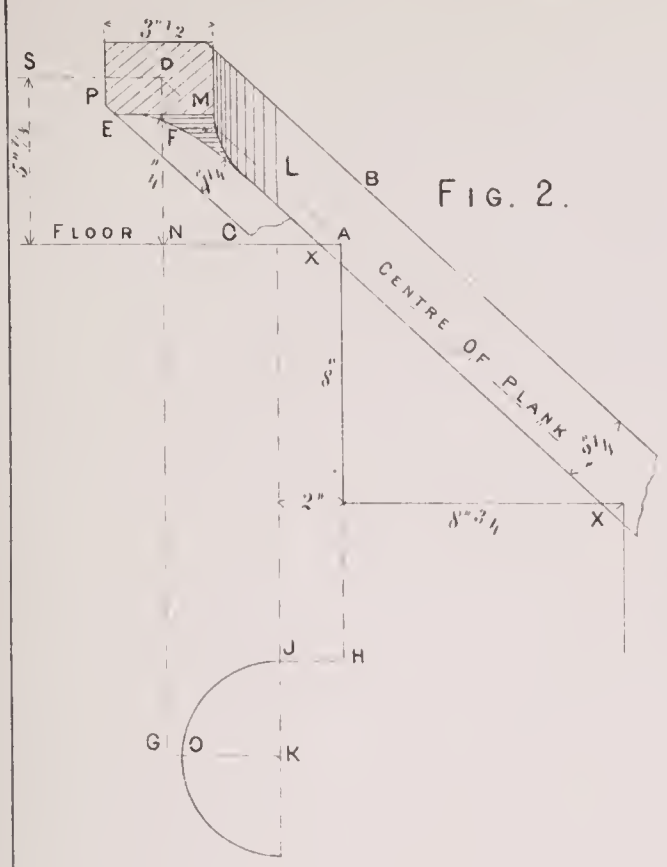

FIG. 2.

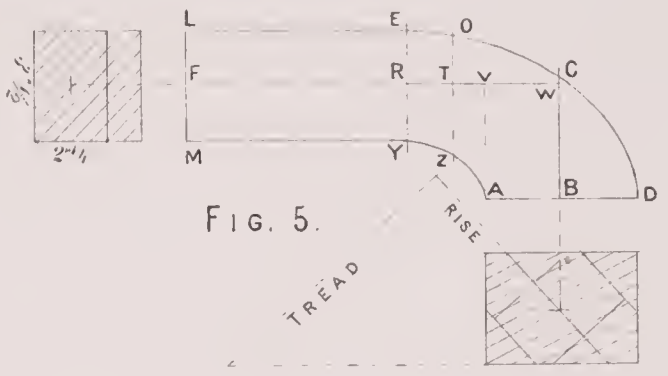

FIG. 5.

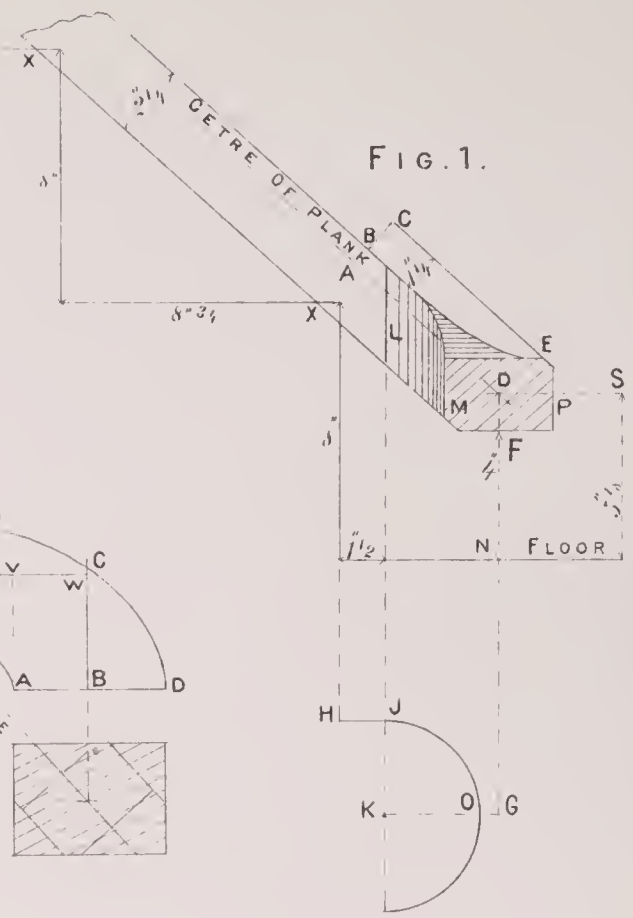

FIG. 1.

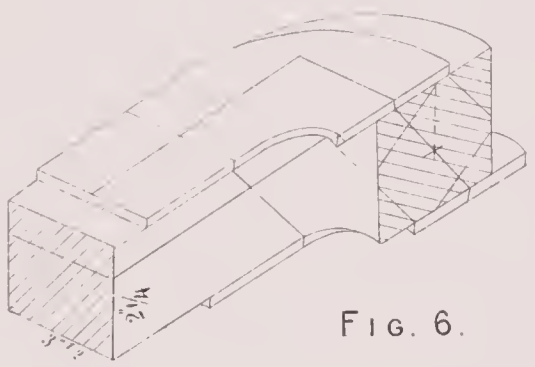

FIG. 6.

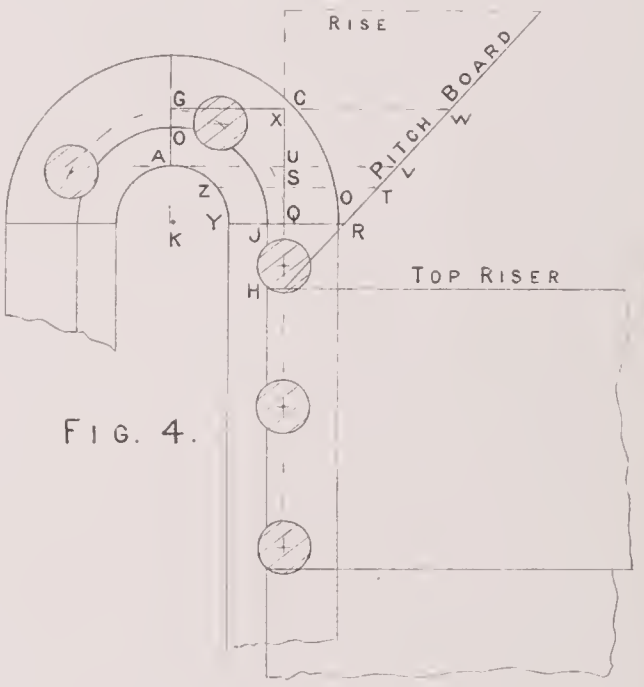

FIG. 4.

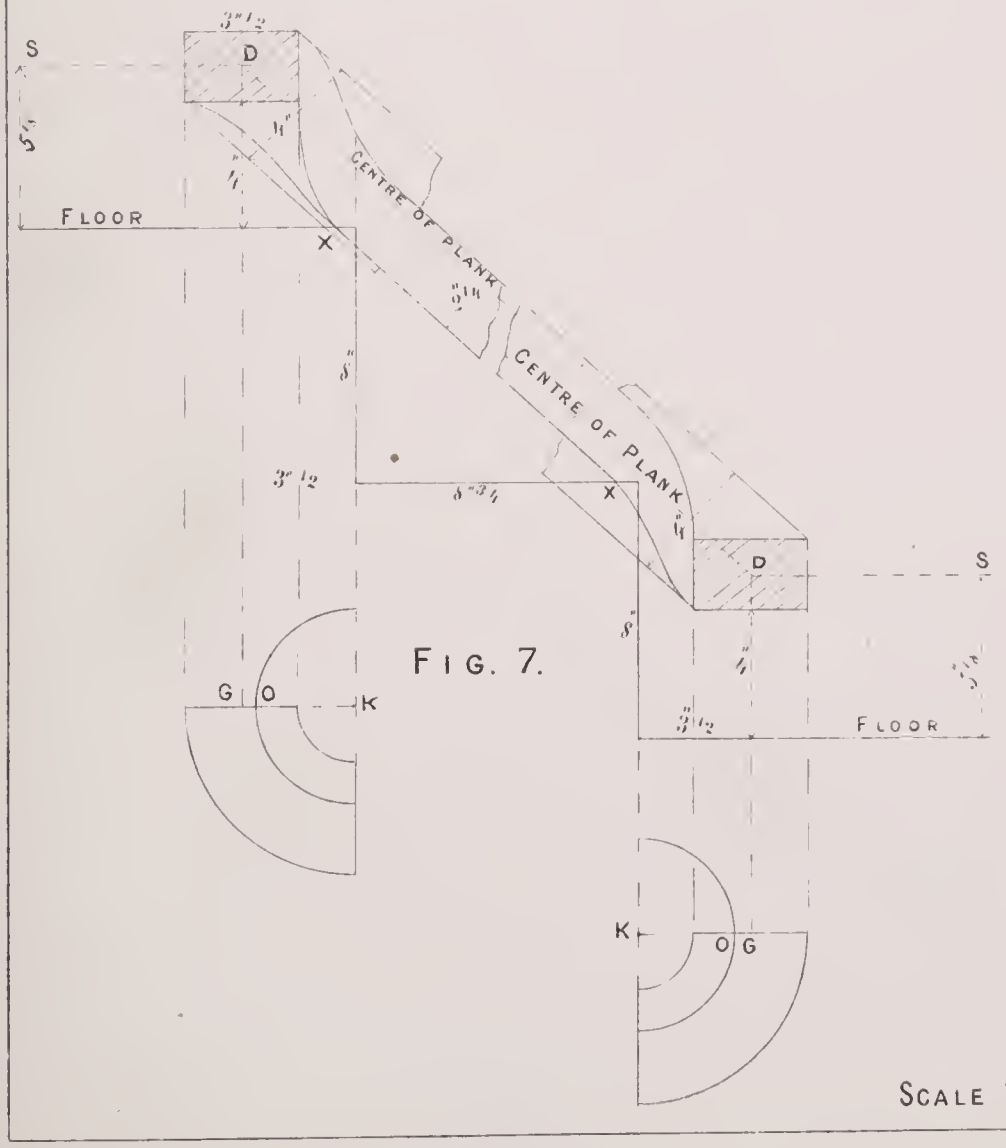

FIG. 7.

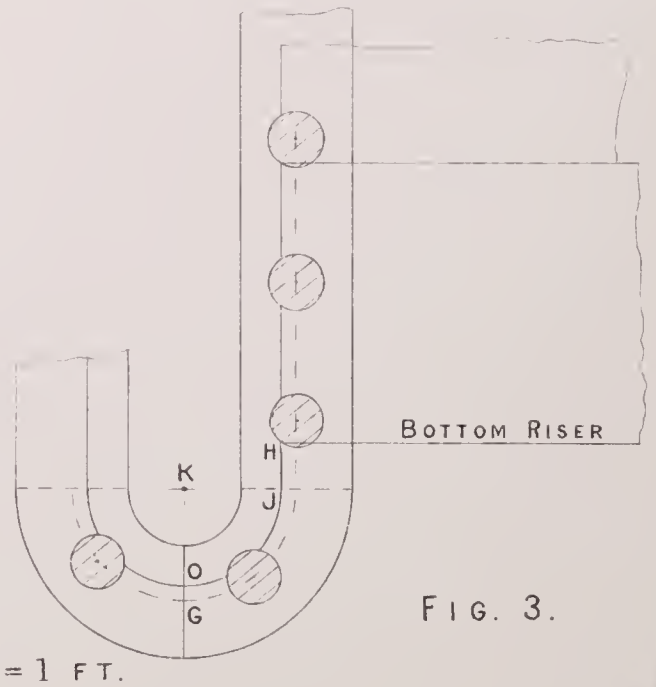

FIG. 3.

SCALE 1½ IN. = 1 FT.

PLATE 23.

PLATFORM STAIRS, HALF-TURN, OR SUCH AS GIVEN BY PLAN AND ELEVATION AT PLATE NO. 1, FIGS. 3 AND 4.—THE POSITION OF CYLINDER WITH THE PLACE OF CONNECTING RISERS, AND THE DIFFERENCES POSSIBLE BY VARYING THE REMOVAL OF OVER WOOD FROM THE STRAIGHT PORTION OF WREATH-PIECES; ALSO HOW TO FIX THE RISERS CONNECTING WITH THE CYLINDER, SO THAT THE WHOLE WREATH MAY HAVE ONE COMMON INCLINATION, BESIDES SAVING SEVERAL INCHES OF STEPPING-ROOM.

Fig. 1. Elevation of Rises and Treads Above and Below the Platform to Test the Removal of Over-wood from the Wreath-pieces.—The bottom line of rail must in all cases pass through the centres of the short balusters X X. As the rail is to be $2\frac{1}{2}''$ thick by $4''$ wide the plank out of which the wreath-pieces are to be worked must be $4''$ thick. Make X B and B C each $2''$; draw B D and C E parallel to X X; make X N and X M $2\frac{1}{2}''$; connect N M; make R U half a rise, $3\frac{3}{4}''$; make U D half the thickness of rail, $1\frac{1}{4}''$; make D F and D S each $2''$, half the thickness of plank; make X J $2\frac{1}{2}''$, the thickness of rail; draw F L, J P and S Q parallel to X X. This drawing shows that keeping the rail above the platform at the height R U and taking all the over-wood off at N C of the upper wreath-piece, the lower wreath-piece must have $\frac{1}{2}''$ of over-wood taken off at J L, the top, and $1''$ off the bottom, X Q. From D parallel to the line of riser draw D G; at right angles to D G draw G K; make G O, $\frac{1}{2}''$, and O K, $3''$, the radius of the cylinder; on the centre K describe the cylinder Y A; parallel to D G through K draw Y V, and continue the line of risers to T Z: then A T will be the distance between the chord-line of the cylinder and the face of the risers at the platform. *Another change can be made by taking all the over-wood off the bottom of the lower wreath-piece*, and this would bring the riser of that side $\frac{3}{4}''$ further from the chord-line of the cylinder—all together $2\frac{1}{2}''$.

Fig. 2. Elevation the Same as that of Fig. 1.—The object in repeating this drawing is to call attention to still another change in removing over-wood. In this case the over-wood is all taken off the bottom of the upper wreath-piece, and off the top of the lower wreath-piece, bringing the chord-line of the $6''$ cylinder to the face of the riser as shown. An inch variation in the height of R U to bring the over-wood as required would be of slight importance. *This arrangement of wreath-pieces and over-wood is not confined to any size of cylinder;* for instance, if the cylinder is to be $12''$ diameter, then, G O being fixed points, O K would be $6''$, and the risers would set just as they are, but would be in the cylinder $3''$. At FIG. 1 a similar change would take place if the size of cylinder is altered; that is to say, that, G O being fixed, if the radius of the cylinder is made less, the chord-line would be drawn nearer O; and if the radius is made greater, the chord-line of the cylinder advances further towards the risers and into the step, as the increase is more or less. *The face-mould for* FIGS. 1 *and* 2 *is to be found exactly as directed at* FIGS. 4 *and* 5 *of* PLATE NO. 22.

Fig. 3. Here again is an Elevation of the Same Tread and Rise Connected with a Platform and the Same Size Cylinder as given at Figs. 1 and 2.—This elevation is introduced for the purpose of showing how, by a wholly different treatment, the wreath in this case, or indeed of any-sized cylinder—within reasonable limits—connected with a platform-stairs as given by plan and elevation at PLATE 1, FIGS. 3 and 4, may be carried around such cylinder on one common inclination, saving room in the stepping, and making a superior shaped wreath. After setting up the elevation, begin by drawing the bottom lines of rail through the centres of short balusters at X X; set off the centre line and the thickness of rail parallel to X X as shown. Draw H F indefinitely; make H N and N F each equal K G, $3\frac{1}{2}''$, the radius of a $6''$ cylinder, and $\frac{1}{2}''$ more to the centre of rail and baluster; through F parallel to the riser-lines draw B S; through N draw M U; at M and J parallel to H F draw J E and M L: then the four heights C E, E F, F L and L B will be equal; anywhere on the line B S at K as centre with $3'' = K O$ as radius describe the cylinder, and with $\frac{1}{2}''$ more radius to G describe the centre line of rail R G P; draw G W, P Q and R V at right angles to P R; make the heights Q T, G W, U V and R S each equal J N; connect S U, V G, W Q and T P: then the four heights and inclinations are set in proper relation to their base, the plan tangents.

Fig. 4. Plan of Rail the Centre Line of which is the Quarter-circle K P G of Fig. 3.—The heights and inclinations Q T P and G W Q are the same as those of like lettering at FIG. 3. Through Q draw S Z; parallel to Q Z draw F E and P B; through G draw P K; on Q as centre draw W K; parallel to Q T draw D C.

To Find the Angle with which to Square the Wreath-piece at Both Joints:—Make G Y equal G X; connect Y Z: then the angle as taken by the bevel at Y will give a plumb-line—H G of FIG. 5—on the butt-joints, by means of which the wreath-piece may be squared.

Fig. 5. Face-mould taken from the Plan Fig. 4; also Showing the Squaring of the Wreath-piece at Both Joints.—On the line K K make A K, A K each equal A K of FIG. 4; make A T at right angles to A K and equal to A Q of FIG. 4; connect K T, KT; make T C, T C each equal T C of FIG. 4; parallel to A T draw K B, K B, C E, C F, C E, C F; make K B, K B each equal P B of FIG. 4; make C E, C F, C E, C F equal D E and D F of FIG. 4; make T S and T R equal Q S and Q R of FIG. 4; through K, K draw the lines F D, F D; make K D, K D each equal F K; continue T K to L, and make K L any length desirable, or equal to A B or C D of FIG. 3; parallel to K L draw D O and F O; make the joints L and K at right angles to the tangents. Through D B E S E B D of the convex and F R F of the concave trace the edges of the face-mould.

NOTE.—At PLATE NO. 11 are given perspective and geometrical drawings and instruction how to form a paper representation of a solid, also a quarter-circle plan of hand-rail, and from this plan a drawing of a face-mould; and at FIG. 7 of that Plate an explanation of the line **K Q A P** of FIG. 4 of this Plate—which together give a practical knowledge of the application and drawing of face-moulds of this kind. *Directions in detail for sliding face-moulds and the correct application of bevels for squaring wreath-pieces will be found at* PLATE NO. 56.

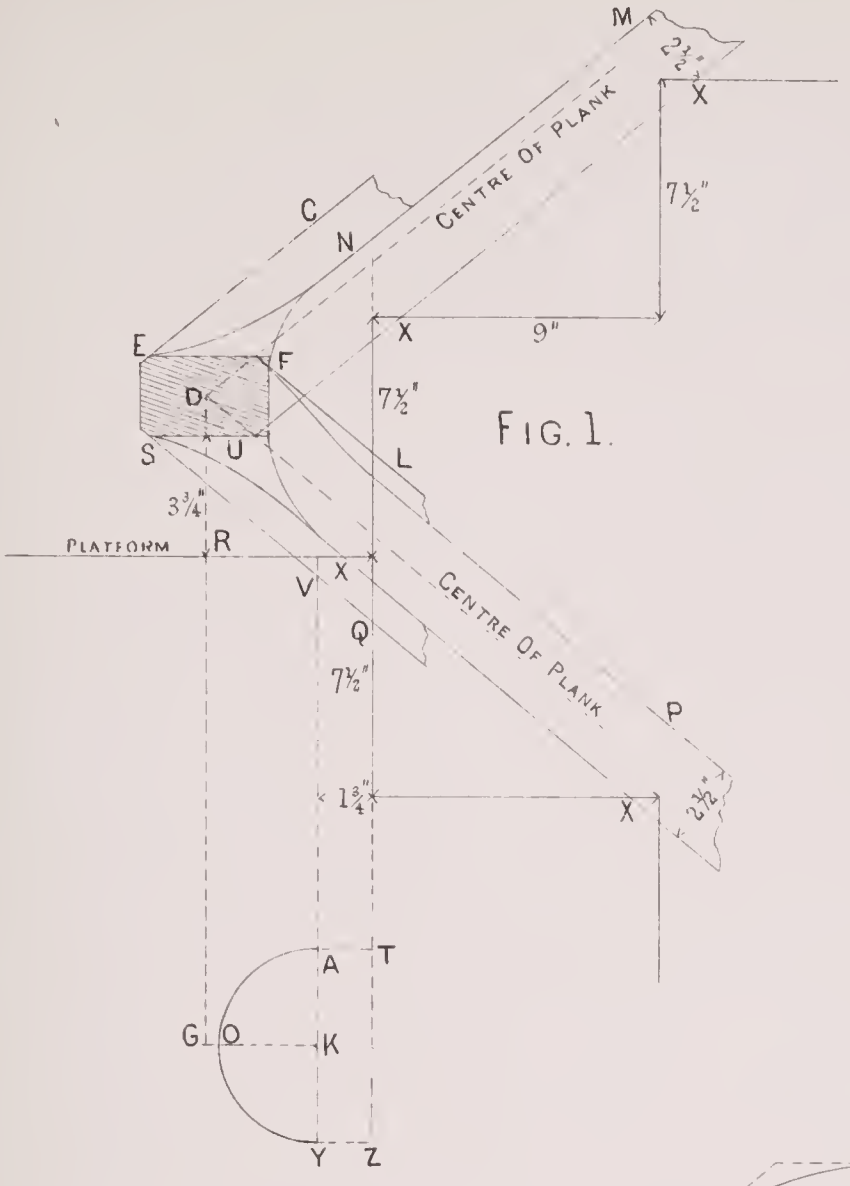

FIG. 1.

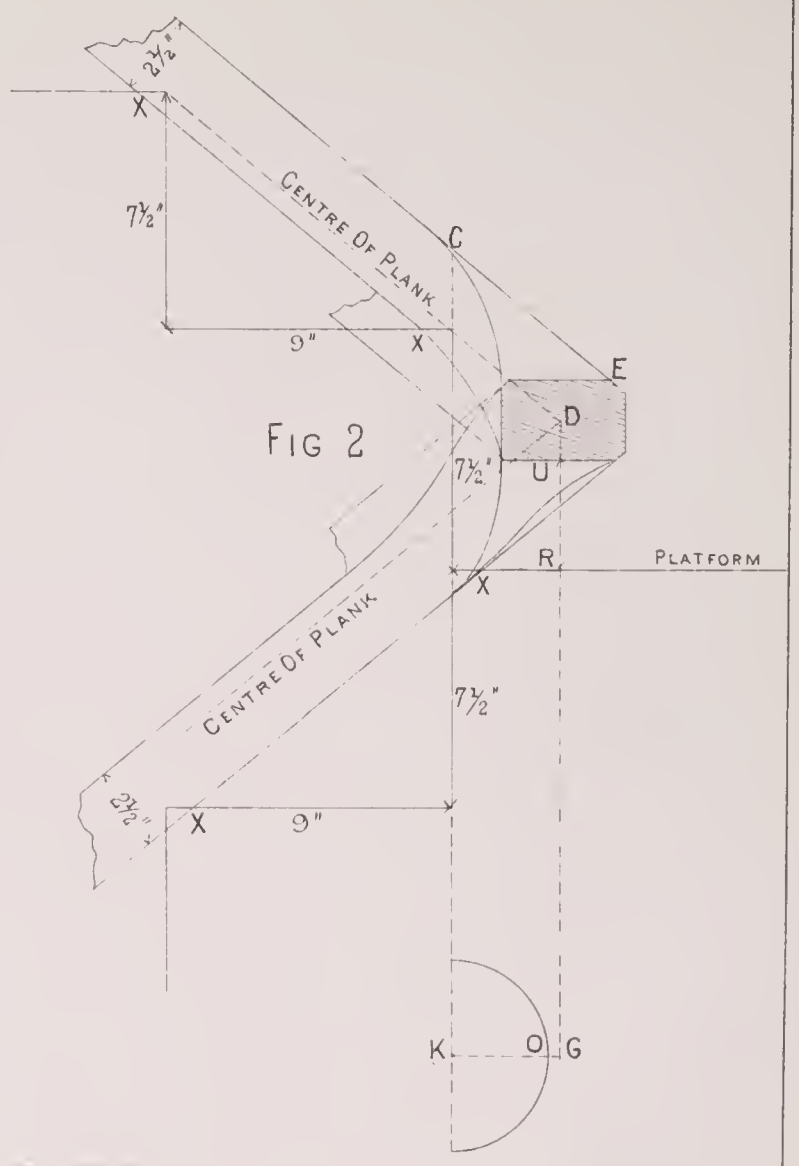

FIG 2

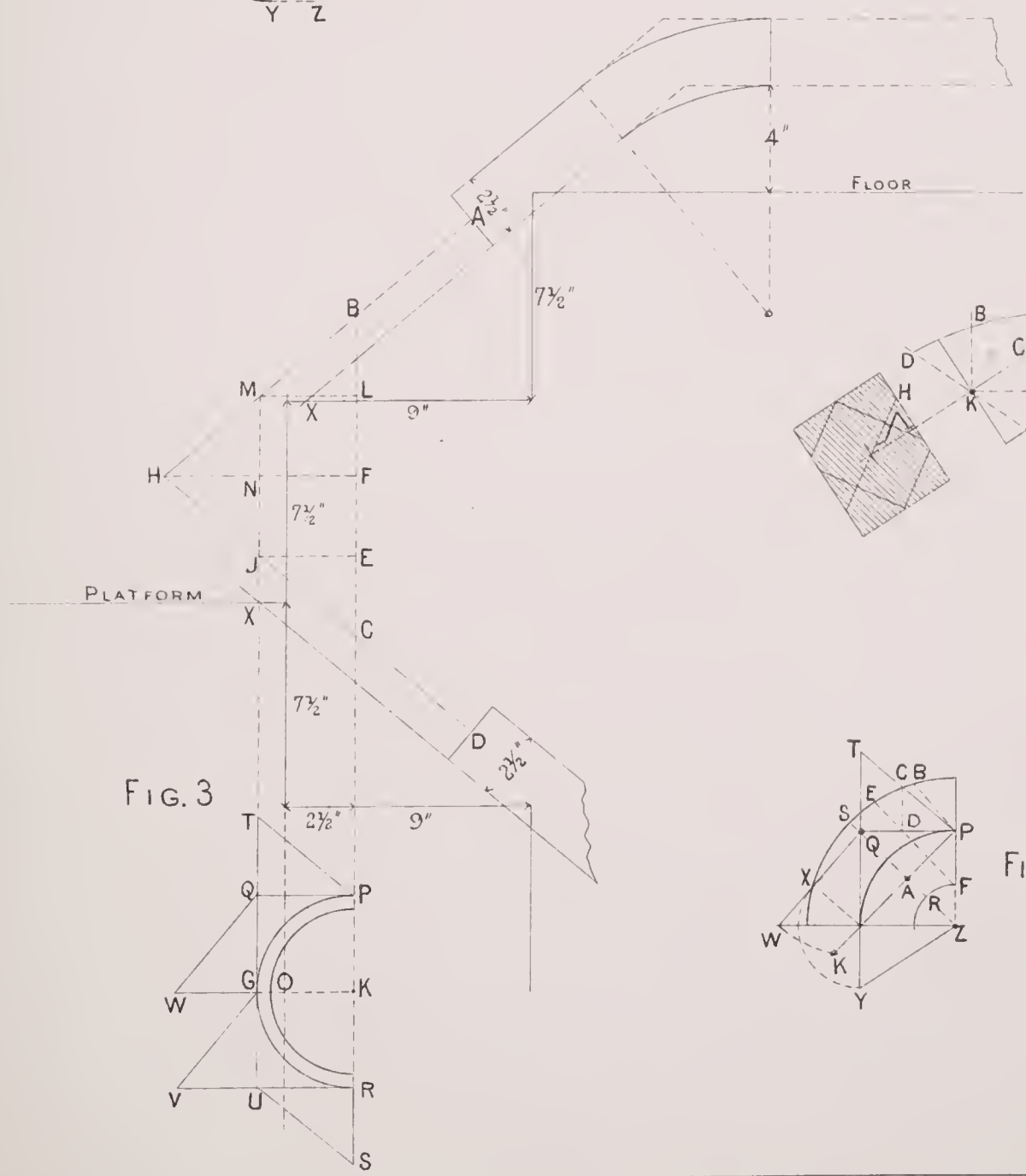

FIG. 3

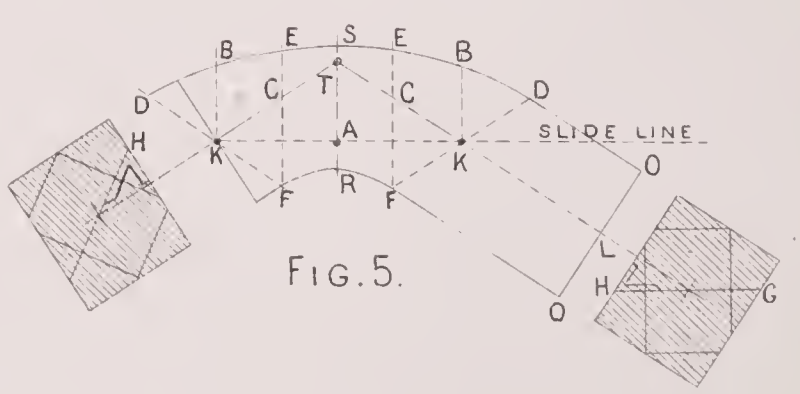

FIG. 5.

FIG. 4.

SCALE 1½ IN. = 1 FT.

PLATE 24.

Figs. 1 and 2. Starting and Landing Elevations Sufficient to Show the Position in the Cylinders of the Starting and Landing Risers.—The cylinders of 15″ diameter; the overwood to be removed from the straight part of wreath-piece the same as at FIGS. 1 and 2 of PLATE No. 22.

Fig. 3. Face-mould from Plan of Hand-rail Fig. 2.—The lettering of face-mould and plan are alike; and as face-mould, plan, and elevations all have been before carefully explained at PLATE No. 22 (the whole being drawn to a scale of $1\frac{1}{2}$″ to the foot), it will not be necessary to repeat the same here.

Where the diameter-line of a large cylinder is placed at the face of a landing-riser it will be necessary to manage the case as explained through FIGS. 4, 5 and 6.* Just here attention may as weli be called to the important fact *that whenever it is desirable the whole radius of cylinders —such as are introduced in this Plate, and also of* FIGS. 1, 2 *and* 7 *of* PLATE No. 22, *and* FIGS. 1 *and* 2 *of* PLATE No. 23—*may be saved or used for step-room, in an entirely unobjectionable and workmanlike manner, if plan and wreath-piece are treated as directed at* PLATE No. 33.

Fig. 4. Elevation of Tread and Rise Sufficient to Take Measurements with which to Prepare the Plan of Hand-rail for the Purpose of Drawing a Face-mould.—Draw the bottom line of rail through X X, the centres of short balusters; parallel to X X draw E D, the centre of the thickness of rail; make R U = 4″, U D = $1\frac{1}{4}$″; from T draw T S parallel to the floor-line; from D at right angles to the floor-line draw D S.

Fig. 5. Plan of Hand-rail with the Top Riser Placed at the Diameter-line of a 15″ Cylinder.—At the centre of the width of rail T, and at right angles to T K, draw the tangents T S indefinitely; from D of FIG. 4 parallel to the line of riser draw a line to S of FIG. 5; make S D equal S D of FIG. 4; connect D T; from S draw the line S M Y tangent to the centre line of the plan of rail; from K at right angles to S Y draw the line K M: then M will be the joint of the wreath-piece, and the remainder of the rail around the cylinder from M to I will be level. Parallel to M S draw N J, O Q and T W; continue M S to A. From T at right angles to S M draw the line T Z indefinitely; on S with D T as radius describe an arc at Z.

To Find the Angle with which to Square the Wreath-piece at the Joint over M:—Make M Y equal S D; connect Y W: then the bevel at Y will give the angle required.

To Find the Angle with which to Square the Wreath-piece over the Joint T:—Prolong the tangent S T to L; make T L equal G V, and connect L J: then the bevel at L will give the angle required.†

Fig. 6. Face-mould taken from the Plan Fig. 5, also Showing the Squaring of the Wreath-piece at Both Joints.‡—On a line E D make D T equal D T of FIG. 5. T E may be any length for straight wood. On T as centre with Z M of FIG. 5 as radius describe an arc at M; on D as centre with S M of FIG. 5 as radius intersect the arc at M; connect M D and prolong M D to S; make T C F equal T C F of FIG. 5; parallel to M D through F, C and T draw U N, R G and T B; make D S equal S A of FIG. 5; make F U and F N equal G H and G N of FIG. 5; make C R and C G equal B O and B Q of FIG. 5; make T B equal T P of FIG. 5; through T draw R O; make T O equal T R; parallel to T E draw R H and O A; make the joints E and M at right angles to the tangents; make M K equal M N; through K S U R of the convex and N G B O of the concave trace the edges of the face-mould. The bevel at Y, showing the squaring of the wreath-piece at joint M, is taken from Y of FIG. 5; and the bevel at L, showing the squaring of the wreath-piece at joint E, is taken from L of Fig. 5.

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* The method of proceeding would be the same at the bottom, or starting, of a staircase.

† The angle required to square a wreath-piece at each joint is, in every case, the inclination of the plane of the plank along the joint given on that plane—which is the joint of the face-mould—and a plumb-line on the butt-joint—which is a joint made square from the face of the plank through its thickness.

‡ At PLATE No. 13 are given perspective and geometrical drawings, and instructions how to form a paper representation of a solid; also a plan of hand-rail less than a quarter-circle, and from this plan a face-mould—which, together, give a practical knowledge of the application and drawing of face-moulds of this kind.

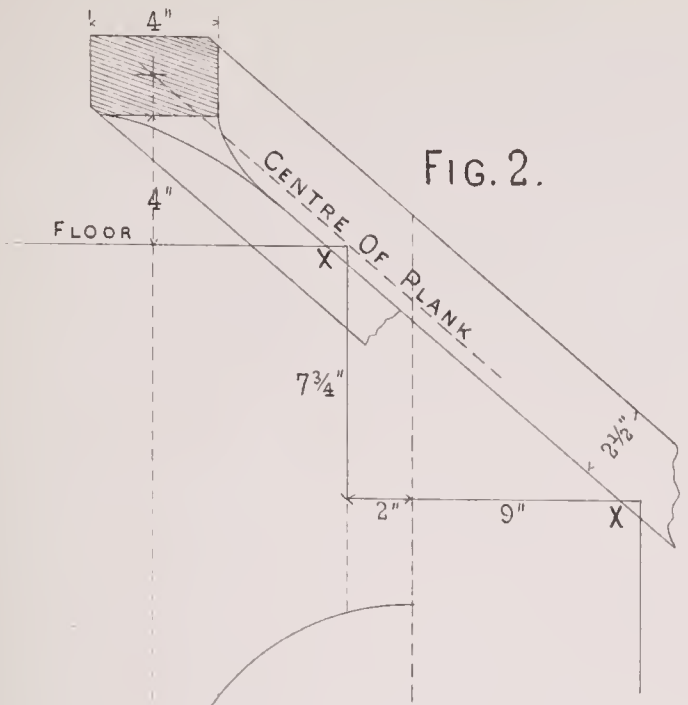


FIG. 2.

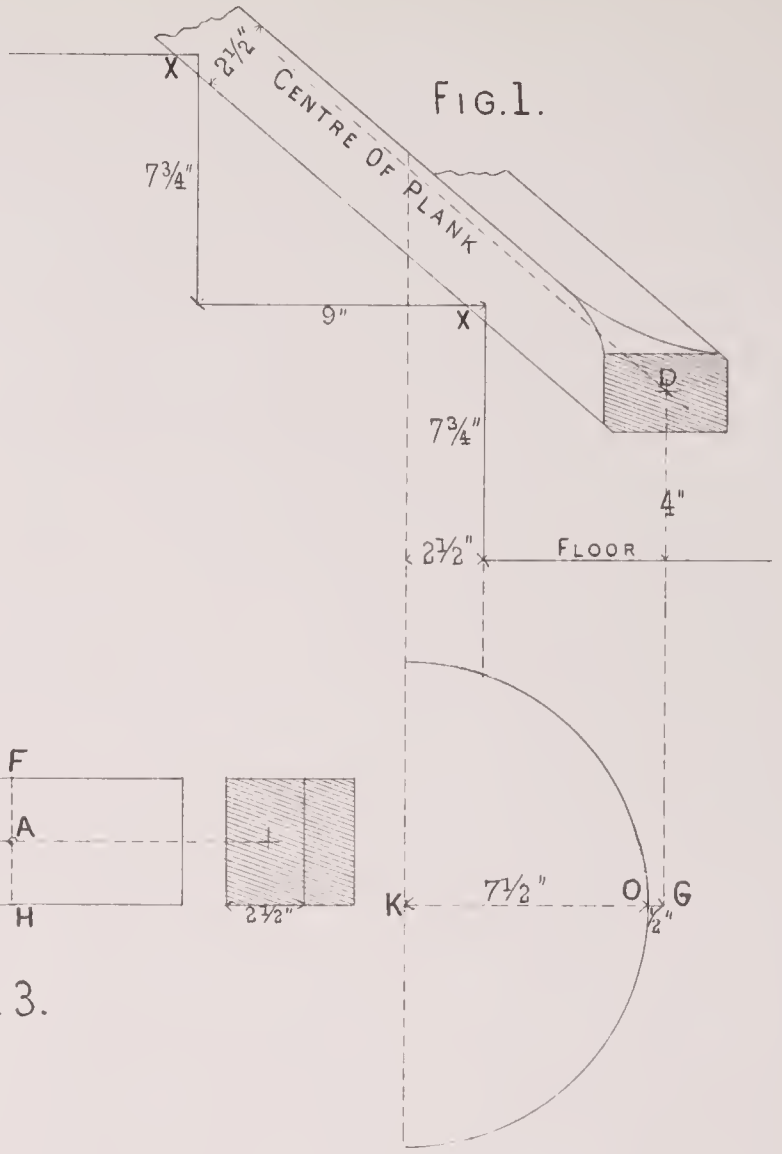
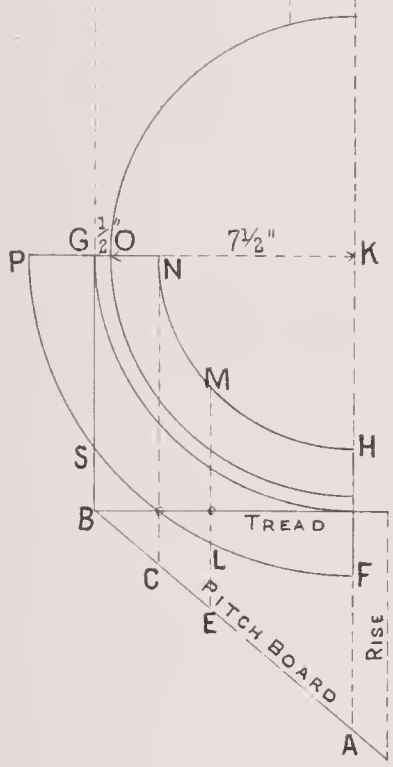


FIG. 1.



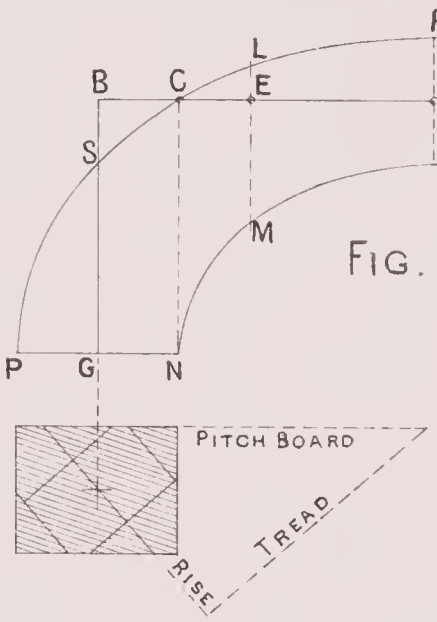


FIG. 3.

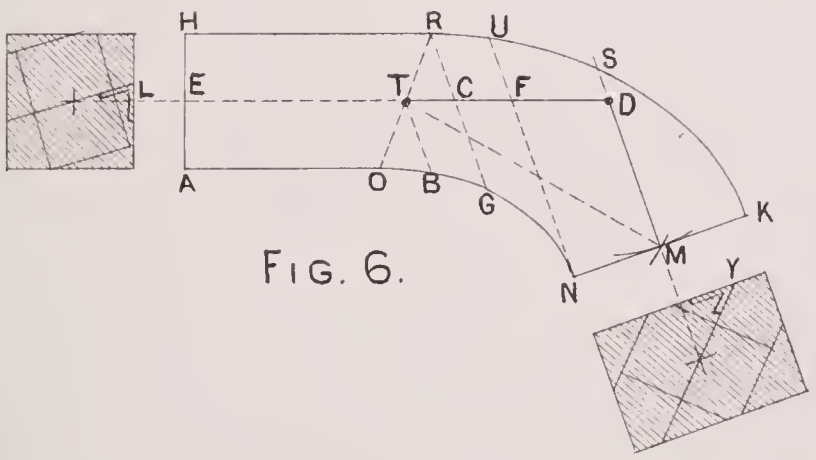


FIG. 6.

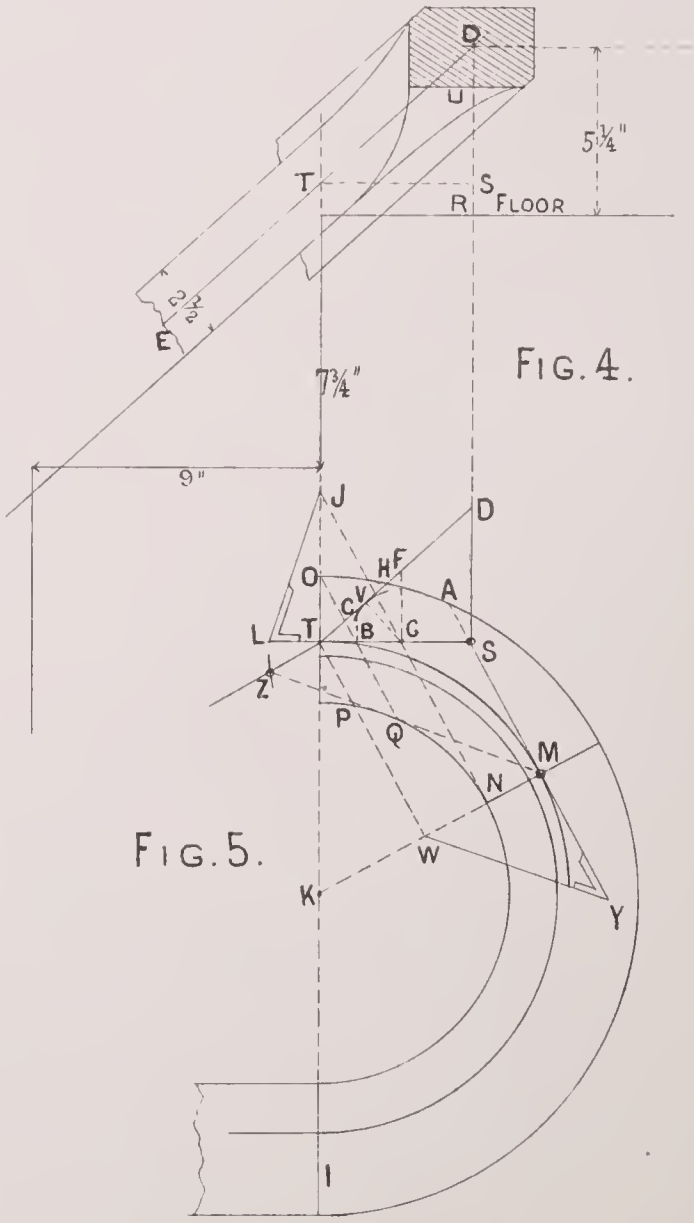


FIG. 4.

FIG. 5.

SCALE 1½ IN. = 1 FT.

PLATE 25.

Fig. 1. Plan of the Top Portion of a Staircase Winding One Quarter, with a Small Cylinder as given at Plate No. 5, Fig. 5.—Let H be the centre of hand-rail and baluster; on A as centre describe the centre line of rail H, E, N; make H B, B M and M N tangents to the centre line of hand-rail. Space the balusters around the centre line of rail and on the winders and steps below as required. Parallel to H B draw A F and M L indefinitely; parallel to A B from O, the centre of baluster, draw O S; prolong M B to J indefinitely; parallel to B J draw S G indefinitely; parallel to M L from the centre of balusters Q and C draw Q K and C D indefinitely. Further heights and inclinations to complete this drawing will be obtained after FIG. 2, the elevation, is set up.

Fig. 2. Elevation of Tread and Rise as Figured, and as Taken from Fig. 1, the Plan.—This elevation is set up for the purpose of finding heights and inclinations over the plan tangents H B, B E and E M of FIG. 1; also through the development of the centre line H G D K L to find the exact relation of the wreath-piece to the steps and rises, and by this means be enabled to get the lengths of balusters wherever placed on the centre line of rail, around the plan of cylinder. The elevation is necessary, too, to make the curve and fix the length and joints of the ramp; also to get the odd lengths of balusters that may occur under the ramp as shown. In practice, the drawing of this elevation, and of such elevations generally, may be done full size, if desired, very conveniently by the use of the pitch-board, laying its hypothenuse along the edge of a drawing-board; and for the winders transferring the tread and rise lines from the pitch-board by the use of a long parallel straight-edge. The treads around the cylinder must be measured on the centre line of rail as follows, at the plan FIG. 1: From H to 1, the first tread in the cylinder, take its measure in two equal parts, and the second step from 1 to 2 into two parts: then 2 N of the remainder of the centre line is on the line of the floor. After completing the elevation anywhere along the line marked chord-line, set off H B, $3\frac{1}{2}''$, equal to H B of FIG. 1. Through B draw B J indefinitely and parallel to T H; at any point along the line B J set off J E equal to B E of FIG. 1. Through E draw E F parallel to B J; at any point along the line E F set off F M equal to E M of FIG. 1; through M draw the line M L indefinitely; from the floor-line to L set up $5\frac{1}{8}''$; then L becomes a fixed point from which the line L R may be drawn, R being the centre line of ramp; R may be raised or lowered to suit, but there can be no change at L. Wherever the line L R cuts the lines T H, B J, E F and M L, as at H, J and F, draw the lines H B, J E and F M parallel to the lines of tread. At FIG. 1 make B J, E F and M L each equal B J of FIG. 2. As the heights are alike, connect J H, F B and L E of the last-mentioned figure. Place the baluster at O the same distance from the chord-line as at H O of FIG. 1, and the other two balusters as at 1 C and 2 Q, as marked alike at FIGS. 1 and 2. Through O, C and Q draw O G, C D and P K parallel to the rises; make S G, C D and P K equal the heights indicated by the same letters at FIG. 1. Through H G D K L trace the centre line of wreath; parallel to this centre line trace the top and bottom lines of the wreath as shown by the short dash-lines. Place the centres of balusters that occur under the ramp as at the plan, and draw the dotted lines parallel to the risers; *then, to find the length of any of the balusters around the wreath or under the ramp;* take for example C 4 of the wreath, which is $2\frac{3}{4}''$, add this to $2'.2''$, the usual height of balusters at X, X, then the baluster at C will be $2'.4\frac{3}{4}''$ at its centre line from the top of step to the under side of the hand-rail or wreath.

Fig. 3. Plan of Hand-rail from the Quarter-circle H E, Fig. 1.—Make the heights and angles B J H and E F B agree with the corresponding letters at FIG. 1; draw A B; from T parallel to A B draw T U; parallel to B J draw O G; through E draw H Z indefinitely; on B as centre with B F as radius describe the arc F Z. To find the angle with which to square the wreath-piece at both joints, prolong B E to R indefinitely; make E R equal E K; connect R A; then the bevel at R will give the angle sought.

Fig. 4. Face-mould from Plan Fig. 3.—On a line Z Z, make V Z, V Z each equal V Z of FIG. 3. At right angles to Z Z draw V M; make V M equal V B of FIG. 3; connect M Z, M Z and prolong M Z to A; make Z A equal H R of FIG. 2; make M G, M G each equal J G of FIG. 3; through G and G parallel to V M draw U T, U T; make G U, G U each equal O U of FIG. 3; make G T, G T each equal O T of FIG. 3; make V S equal V S of FIG. 3; through Z and Z draw T F, T F; make Z F, Z F equal Z T, Z T; make T B parallel to M Z; make F O and T D parallel to M A; make the joints A and Z at right angles to the tangents. Through F U M U F of the convex and T S T of the concave trace the edges of the face-mould. The squaring of the wreath-piece at both joints is shown through the use of the bevel R, R taken from R of FIG. 3.

Fig. 5. Plan of Hand-rail from the Quarter-circle E N, the Tangents E M and N M of Fig. 1.—Make the angle M L E equal that given at M L E of FIG. 1; parallel to M L draw U O and V Q.

Fig. 6. Face-mould from Plan Fig. 5, also Showing the Squaring of the Wreath-piece at Both Joints.—Draw the lines M F and M X at right angles; make M N equal M N of FIG. 5; make the straight wood N X from 2" up, at pleasure. At right angles to X M through X and N draw Z U and D E; make M O Q F equal L O Q E of FIG. 5. Through O, Q and F parallel to X M draw W Y, V C and E S; make F Y, F W equal E Y, E W of FIG. 5; make Q C and Q V equal R C and R V of FIG. 5; make O S equal Z S of FIG. 5; make N Z equal N U; make Z D parallel to N X. Through Y C S M Z of the convex and W V U of the concave trace the edges of the face-mould. The bevel L used to square the wreath-piece at the joint X is from L of FIG. 5. *The case of face-mould* FIG. 4 *is treated in detail at* PLATE No. 11, *and face-mould* FIG. 6 *is likewise treated at* PLATE No. 10. The development of the centre line of the wreath H G D K L of FIG. 2 is illustrated and explained in detail at PLATE No. 20, FIGS. 1 and 2. Sliding face-moulds to plumb the sides of wreath-pieces, also directions for the application of bevels to square wreath-pieces, is given at PLATE No. 56.

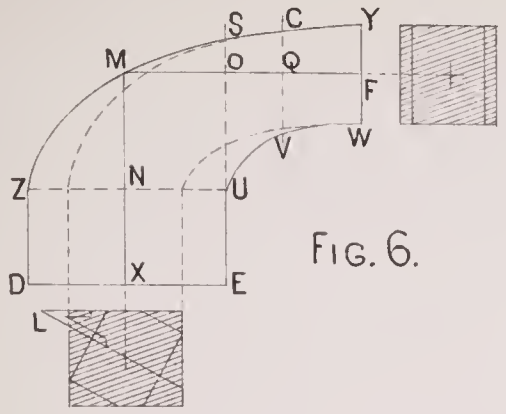


FIG. 6.

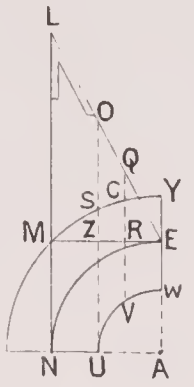


FIG. 5.

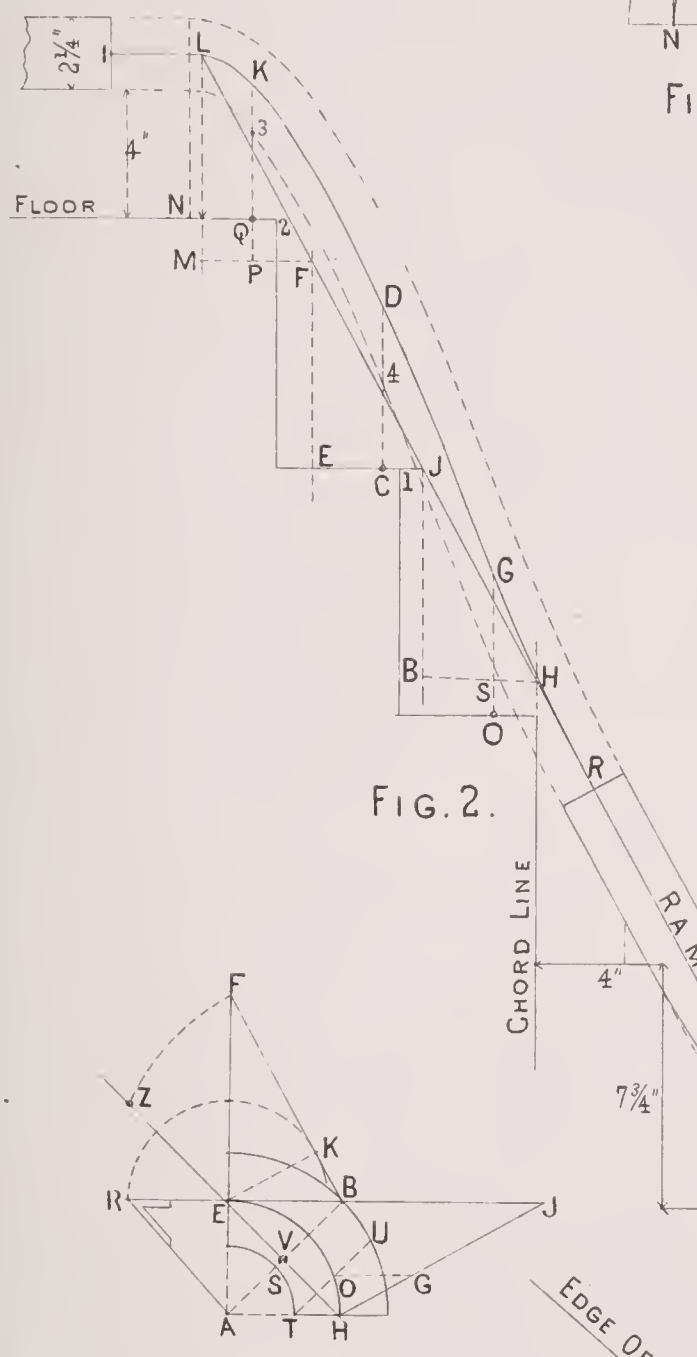


FIG. 2.

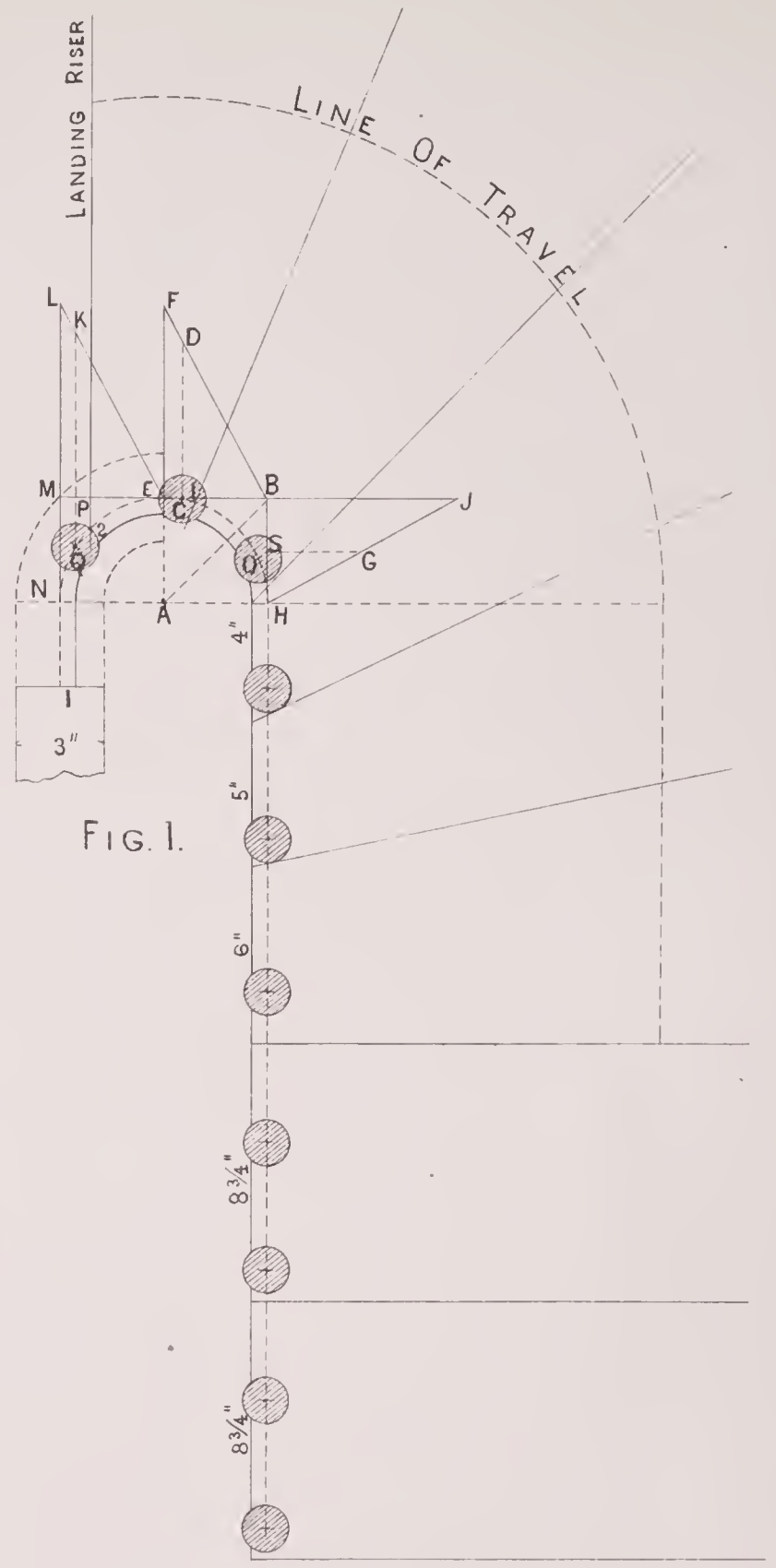


FIG. 1.

FIG. 3.

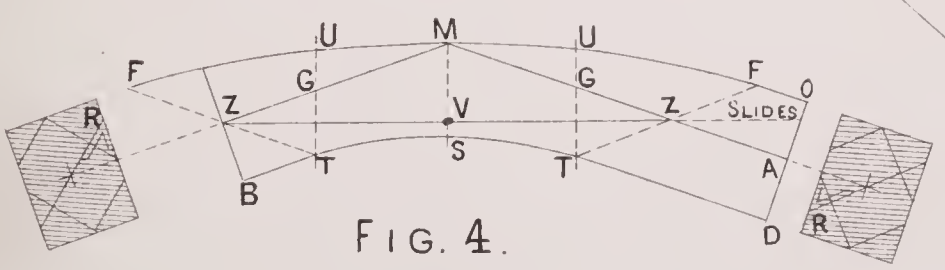


FIG. 4.

SCALE 1½ IN. = 1 FT.

PLATE 26.

Fig. 1. Plan of the Top Portion of a Staircase Turning One Quarter to the Landing with Diminished Steps Around the Cylinder, Curved Rises, and Platform as given at Plate No. 5, Fig. 6.—This is an improved plan of stairs turning one quarter without the winders as by the old method given at PLATE No. 25, but the treatment of the hand-rail is precisely the same as that at the last-mentioned Plate, because the conditions around the cylinder are alike; so that if the explanation is not given in this case with quite as much detail as before, it is for the reasons stated. It would be well to make a careful study of the preceding Plate in connection with this. Let F C A be the centre line of hand-rail and F D C, C B A the tangents. Place the balusters around the centre line of hand-rail as shown. Prolong F D to G indefinitely, and prolong K C to J indefinitely; also D B to N. Connect K B; from L parallel to K B draw L O; from O parallel to B N draw O M indefinitely; from E parallel to F G draw E H indefinitely. The necessary heights and inclinations to complete this drawing will be established by drawing the elevation, and proceeding as directed at FIG. 2.

Fig. 2. Elevation of Treads and Rises as Figured and as Taken from Fig. 1, the Plan.—From the chord-line, which is the commencement of the cylinder, the treads are to be measured on the centre line of rail, from A to Z in two parts, and from Z to Q in two parts; also on the line of floor Q F in two parts. *Measuring the treads in two parts is done to get more exactly the stretch-out of the centre line.* After drawing the elevation set off from the chord-line the length of tangent A B of FIG. 1 (which in this case is $3\frac{1}{2}''$) three times as shown, drawing lines at each of these distances parallel to the chord-line, to N J and G indefinitely; make the height from the line of floor to G equal $5\frac{1}{8}''$: then G becomes a fixed point from which the line G R may be drawn, R being the centre line of ramp it may be raised or lowered to suit, but no change can be made at G without changing the usual length of balusters. Where the line G R cuts the lines I J, B N and the chord-line as at J, N and A, draw the lines A B, N I and J D parallel to the lines of tread. At FIG. 1 make B N, C J and D G each equal B N of FIG. 2, and connect G C, J B and N A. Place the centre of balusters L, F and E as on the plan L C and E FIG. 1, measuring from each riser on the centre line except the first baluster, which is measured from A, the chord, to L, the centre of baluster; parallel to the rise lines through E, F and L draw P H, F B and L M indefinitely; make P H equal P H of FIG. 1; make C B equal C J of FIG. 1; make O M equal O M of FIG. 1; then through G H B M A trace the centre line of wreath;* parallel to this centre line set off and trace the top and bottom lines of the wreath as shown by the dotted lines.

To Find the Length of any Baluster around the Wreath, take for Example:—F K, which is $3\frac{1}{2}''$; add this to $2'.2''$ the height of balusters at X X: then the baluster at F will be $2'.5\frac{1}{2}''$ at its centre line from the top of step to the under side of the wreath.

Fig. 3. Plan of Hand-rail from the Quarter-circle C F, the Tangents C D and F D of Fig. 1.—Make the angle D G C equal the angle D G C of FIG. 1. From R and S parallel to F G draw R Y and S X.

Fig. 4. Face-mould from Plan Fig. 3, also Showing the Squaring of the Wreath-piece at Both Joints.†—Draw the lines C G and G B at right angles; let G F equal D F of FIG. 3; F B the straight wood added should never be less than $2''$; through F and B parallel to G C draw R A and D C indefinitely; make G Y X C equal G Y X C of FIG. 3; through C at right angles to G C draw Z I; through Y and X parallel to F G draw D V and S W indefinitely; make F A equal F R; draw A C parallel to F B; let Y V, X W and C I equal U V, T W and C I of FIG. 3; let X S and C Z equal T S and C Z of FIG. 3. Through A G V W I of the convex and R S Z of the concave trace the edges of the face-mould. The bevel G of FIG. 3 is used to square the wreath-piece at the joint B as shown. The dotted lines show the least wood required to form the wreath-piece.

Fig. 5. Plan of Hand-rail from the Quarter-circle A C, Tangents C B and A B of Fig. 1.—Let the angles C J B and B N A each equal B N A of FIG. 1. Connect P B; from S draw S V parallel to P B; from U draw U T parallel to B N; through A C draw A L indefinitely: on B as centre with B J as radius describe the arc J L.

To Find the Angle with which to Square the Wreath-piece at Both Joints:—Prolong B C to Q indefinitely; on C as centre with C W as radius describe the arc W Q; connect Q P: then the bevel Q will give the angle required.

Fig. 6. Face-mould from Plan‡ Fig. 5, also Showing the Squaring of the Wreath-piece at Both Joints.—Let C J and C A each equal M L of FIG. 5. Draw C N at right angles to A J; make C N equal M B of FIG. 5; connect N J and N A; prolong N A to R indefinitely; make A R equal A R of FIG. 2; make the joints R and J at right angles to the tangents; let C Y equal M R of FIG. 5; make T O, T X and T O, T X both equal U V and U S; through J draw X Z, make J Z equal J X; through A draw X Z; make A Z equal A X; parallel to A R draw Z W and X S; parallel to N J draw X F; through Z O N O Z of the convex and X Y X of the concave trace the edges of the face-mould. The bevel Q used to square the wreath-piece at the joints J and R is taken from Q of FIG. 5.

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* The development of the centre line of a wreath, as in this case, is illustrated and explained in detail at PLATE 20, FIGS. 1 and 2.

Sliding face-moulds to plumb the sides of wreath-pieces, also directions for the application of bevels to square wreath-pieces, are given at PLATE No. 56.

† The face-mould FIG. 4 is explained in detail at PLATE No. 10.

‡ Face-mould FIG. 6 is explained in detail at PLATE No. 11.

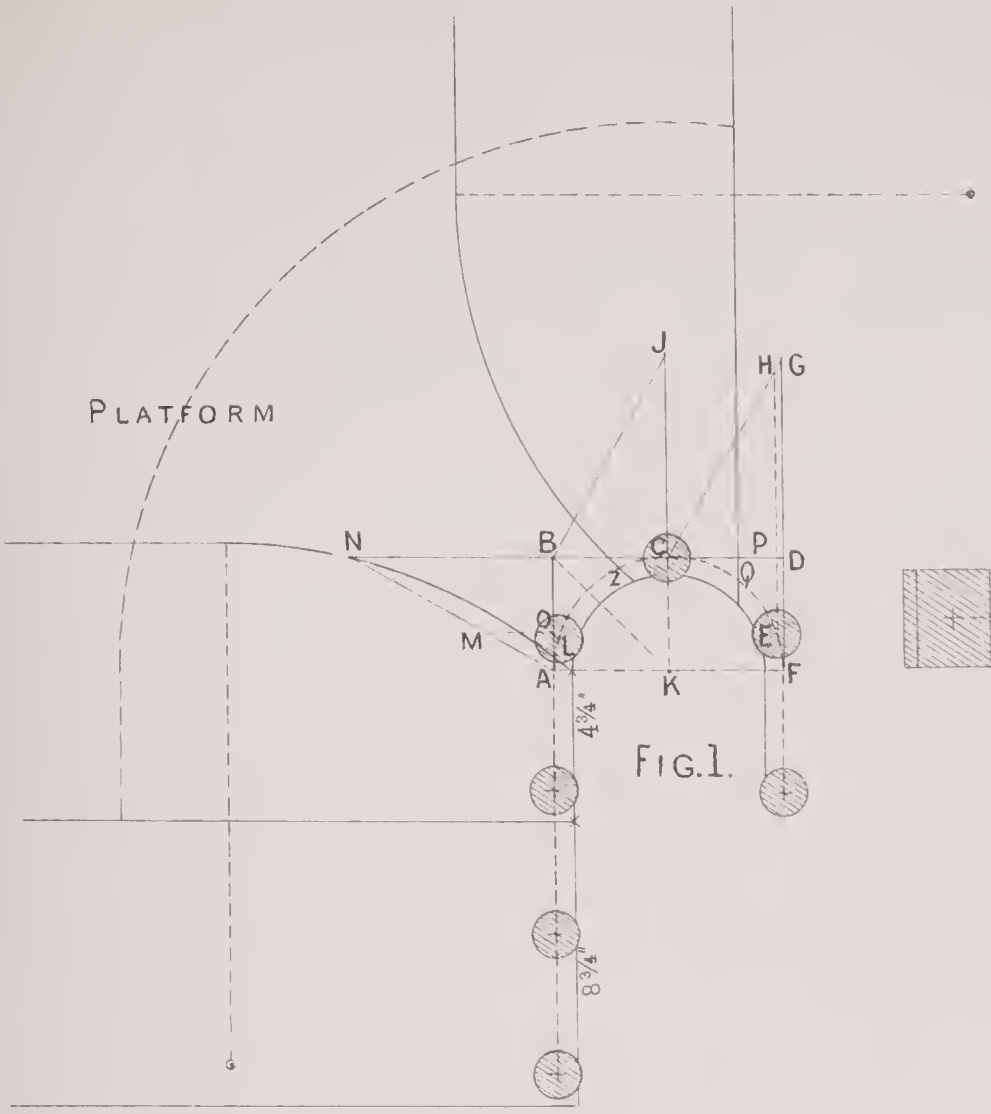


FIG. 1.

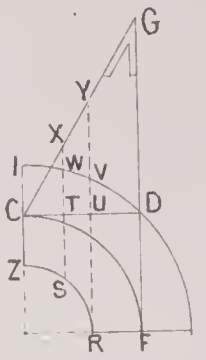


FIG. 3.

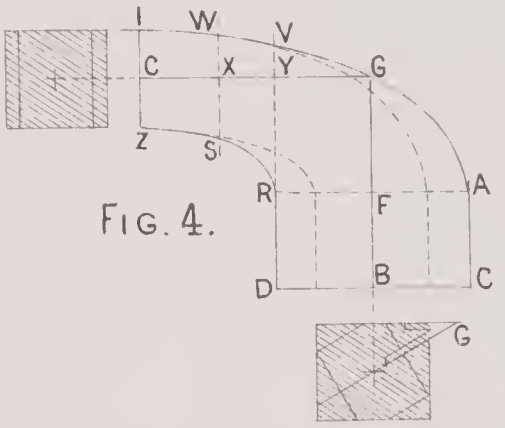


FIG. 4.

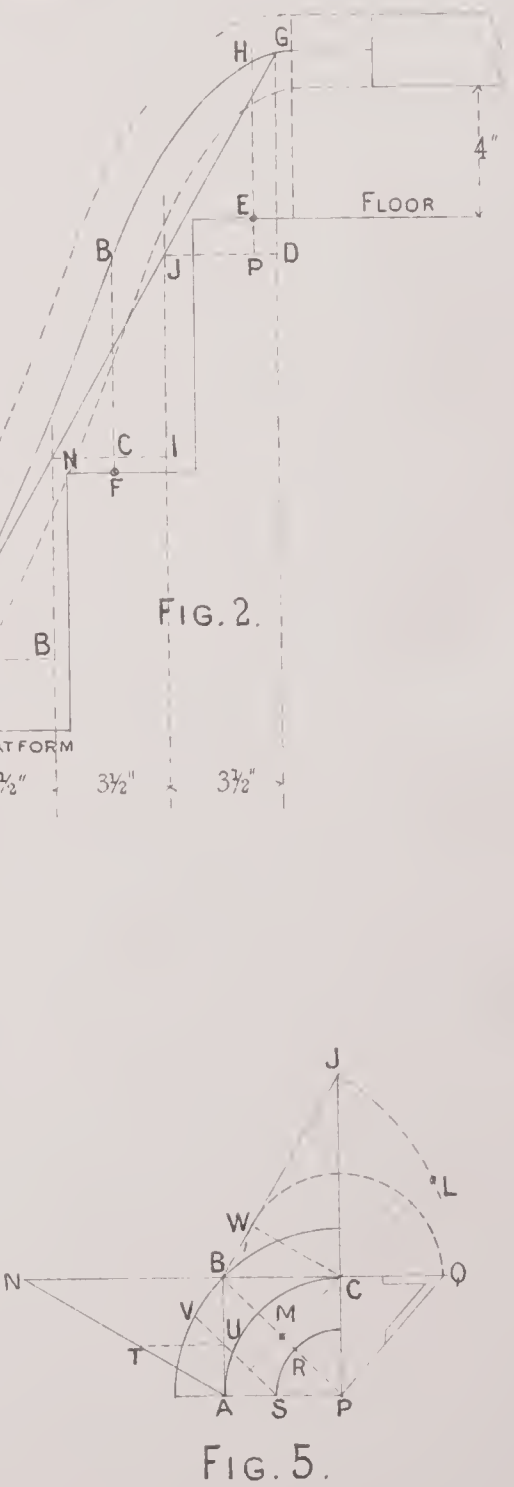


FIG. 2.

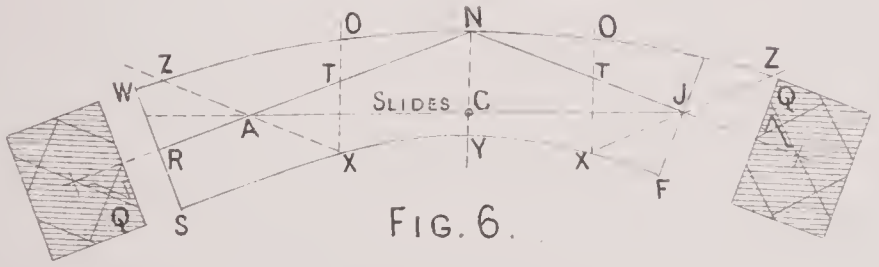


FIG. 6.

FIG. 5.

SCALE 1½ IN. = 1 FT.

PLATE 27.

Fig. 1. Plan of the Bottom or Starting Portion of a Staircase Winding One Quarter, Similar to Plan Fig. 1 of Plate No. 4.—Let A C F be the centre line of rail around the cylinder, and A B, B D and D F tangents. Prolong F A to Q indefinitely; prolong A B to N and H C to T indefinitely. Space the balusters on the centre line as shown. Further heights and inclinations necessary to complete this drawing will be obtained as directed from the elevation FIG. 2, when that drawing is completed.

Fig. 2. Elevation of Tread and Rises as Figured and as Taken from Fig. 1, the Plan.—Besides finding heights and inclinations over tangents, this elevation is also set up to develop the centre line of wreath D U L P Q in its exact relation to the step and rise, thus giving the lengths of balusters under the wreath. The treads in the cylinder must be measured around the centre line of rail, and each tread taken in two parts in order to get more exactly the stretch-out of the circular line. After completing the elevation, anywhere along the line marked chord-line,—which is the commencement of the cylinder,—set off H A or A B of FIG. 1 (either of which is $5\frac{1}{2}''$) three times, drawing lines parallel to the chord-line indefinitely as shown. Let X X at the centres of the short balusters be the bottom line of rail; draw R N, the centre line, indefinitely and parallel to X X; at the intersection, N, draw N A at right angles to the chord-line; make Q R, 3", for straight wood to be added to that end of wreath-piece. Make E D, $5\frac{1}{4}''$; connect D N; at T and D draw the lines D C and T B parallel to the treads. At FIG. 1 make C T and B N each equal C T and B N of FIG. 2; let A Q equal A Q of FIG. 2; connect Q B, N C and T D; make B O equal A Q; parallel to B C draw O M; parallel to B O draw M G; connect G H, the level line common to both planes; parallel to G H draw J K and S R; parallel to A Q draw R P; parallel to T C draw K L and Z U. At FIG. 2 the centre of balusters E Z J and S are placed on each tread as at the plan, and the lines S P, J L and V Z U are drawn indefinitely and parallel to the rise-lines; make V U and K L equal V U and K L of FIG. 1; make G P equal R P of FIG. 1; through the points D U L P Q trace the centre line of wreath; the dotted lines are the top and bottom of wreath set off from the centre line. D H is straight wood that will be added to that end of the lower wreath-piece.

To Find the Lengths of Balusters Around the Wreath:—Take for example the baluster at S; S F is $5\frac{1}{4}''$, which, added to the usual height of balusters at X X, 2'.2", makes the height of this baluster on its centre line from the top of step to under-side of wreath 2'.$7\frac{1}{4}''$.

Fig. 3. Plan of Hand-rail from the Quarter-circle F C of Fig. 1 with the Tangents F D and D C.—Make C T D equal C T D of FIG. 1; parallel to F D draw P B and Q A.

Fig. 4. Face-mould from Plan Fig. 3; also Showing the Squaring of the Wreath-piece at Both Joints.—Make the lines N D and D I at right angles; let D B A N equal D B A T of FIG. 3; let D F equal D F of FIG. 3, and F I equal D H of FIG. 2; parallel to N D through F and I draw K M and J L; through B, A and N draw R L, O H and E G parallel to D F; make D J, B R, A O, N E and N G each equal D J, K R, X O and C E of FIG. 3; make A H equal X Q of FIG. 3; make F K equal F M; make K J parallel to F I; through M H G of the concave and K J R O E of the convex trace the edges of the face-mould. *The bevel at* T *used to square the wreath-piece at joint* I *is taken from* T *of* FIG. 3. The dotted lines show the width of wood required to work out the wreath-piece. This face-mould is explained in detail at PLATE NO. 10.

Fig. 5. Plan of Hand-rail from the Quarter-circle A C of Fig. 1 with the Tangents A B and C B.—The angles of inclination B N C and A Q B are taken from FIG. 1. Make B O equal A Q; make O 6 parallel to B C, and 6 S parallel to O B; connect S H, the level line common to both planes. Parallel to S H draw Y R, 5 L, B G, T U and A V; parallel to B O draw 4 M and R P; parallel to A Q draw U W; at right angles to H S draw A E indefinitely; draw C K at right angles to H S; on B as centre with N C as radius describe an arc at K; again on B as centre with B Q as radius describe the arc Q E; connect E K.

To Find the Angles with which to Square the Wreath-piece:—Prolong B A to F indefinitely and A H to J indefinitely; make A F equal A D; connect F G: then the bevel at F will square the wreath-piece over the joint A. Make H J equal S X; connect J C: then the bevel at J will square the wreath-piece over the joint C.

Fig. 6. Face-mould from Plan Fig. 5; also Showing the Squaring of the Wreath-piece at Both Joints.—Draw the line K Q; let Z Q and Z K equal Z E and Z K of FIG. 5. On Z as centre with Z B of FIG. 5 as radius describe an arc at B; make Q B equal Q B of FIG. 5, and K B equal C N of FIG. 5; connect K B, B Q and B Z; make B W equal B W of FIG. 5: make B M 6 P equal N M 6 P of FIG. 5; parallel to Z B draw Q V, M L 5, 6, 3, 1 and P Y: make Q V and W T equal A V and U T of FIG. 5; make Z 2, M L and M 5 equal Z 2, 4, 5 and 4 L of FIG. 5; make 6, 3, 6, 1, P Y equal S I, S 3 and R Y of FIG. 5; through Q draw the line T C; make Q C equal Q T; through K draw the line Y A; make K A equal K Y; parallel to B E draw T D indefinitely; make Q E equal Q R of FIG. 2. The joints E and K are made at right angles to the tangents. Through A 3 L 2 V C of the convex and Y I 5 T of the concave trace the edges of the face-mould. The slide-line is drawn at right angles to B Z. The dotted lines show the least width of wood required to work out the wreath-piece. This face-mould is explained in detail at PLATE NO. 12. The development of the centre line of this case of wreath is given in detail at PLATE NO. 20, FIGS. 3 and 4. Sliding face-moulds to plumb the sides of wreath-pieces, also direction for the application of bevels to square wreath-pieces, is given at PLATE NO. 56.

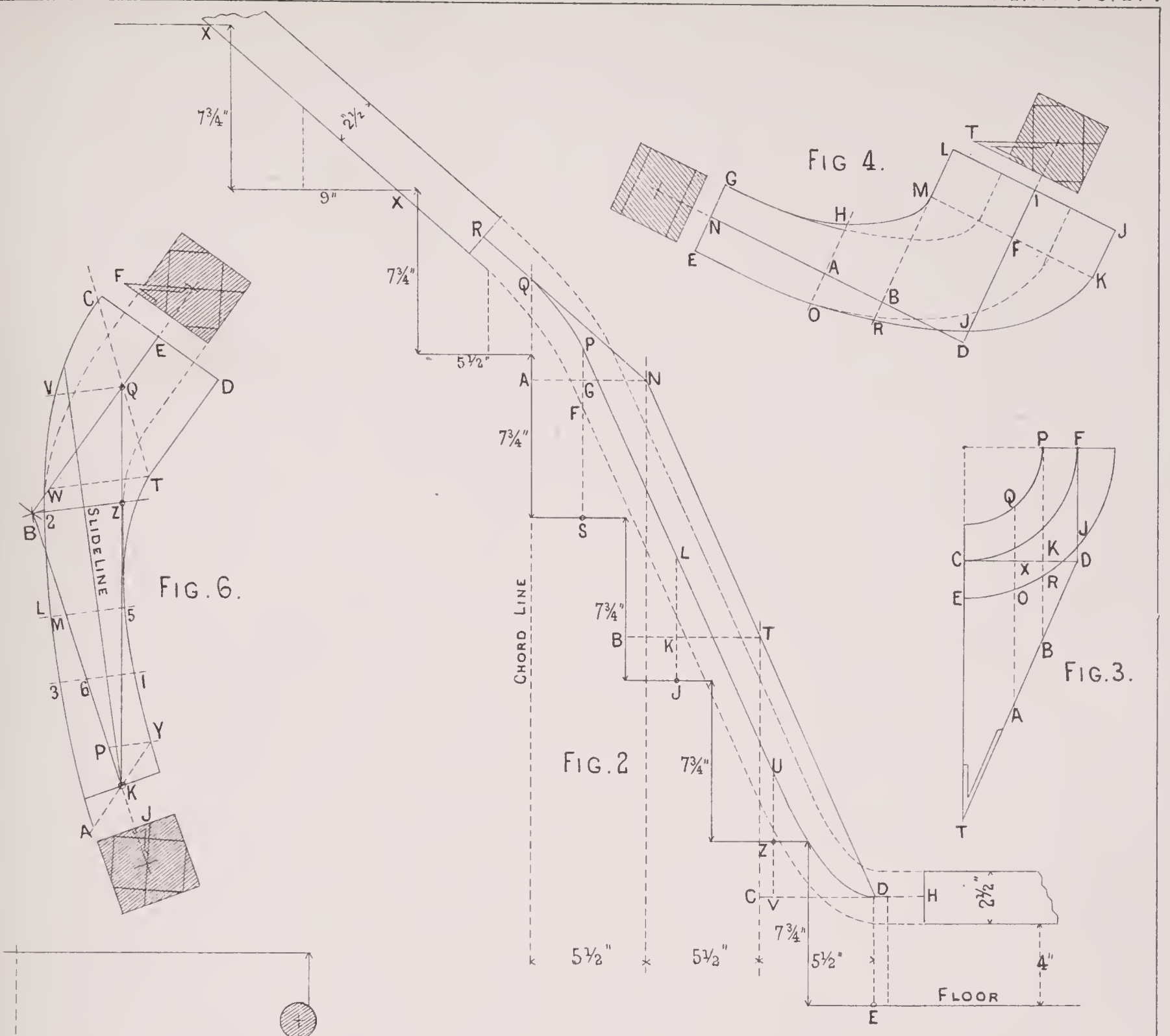


FIG. 2

FIG 4.

FIG. 6.

FIG. 3.

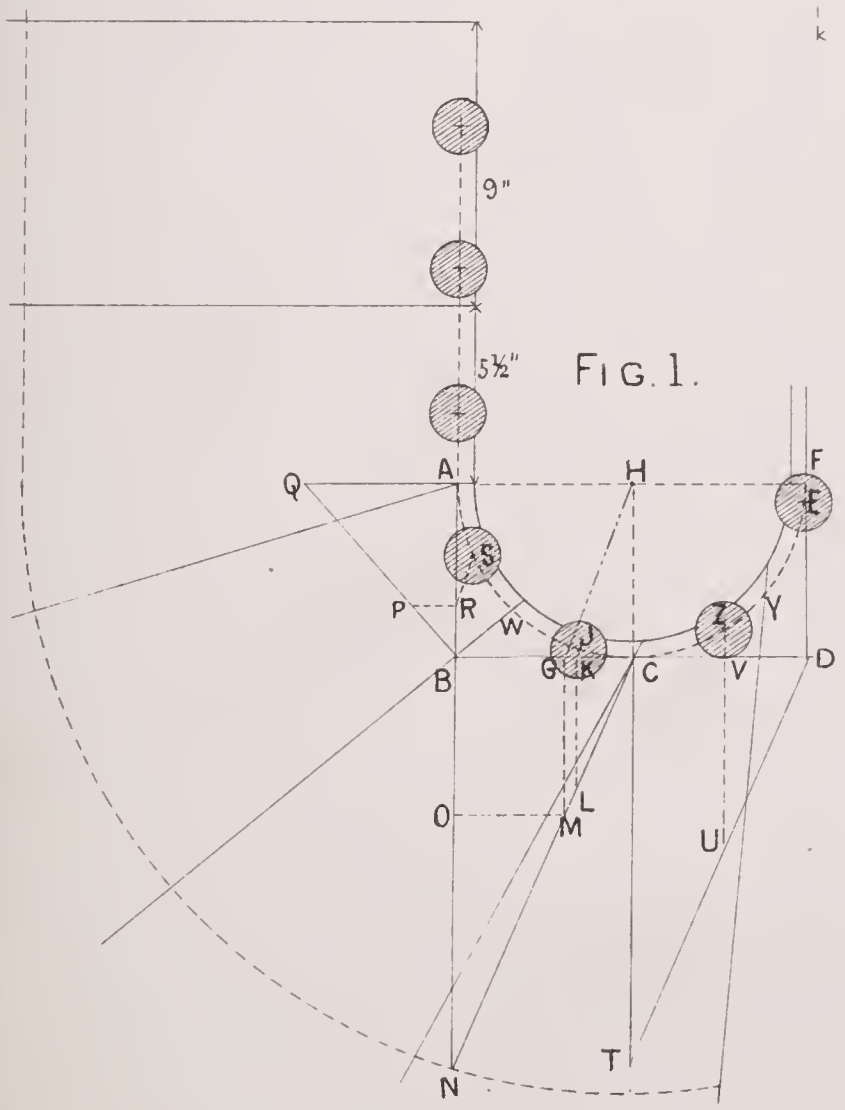


FIG. 1.

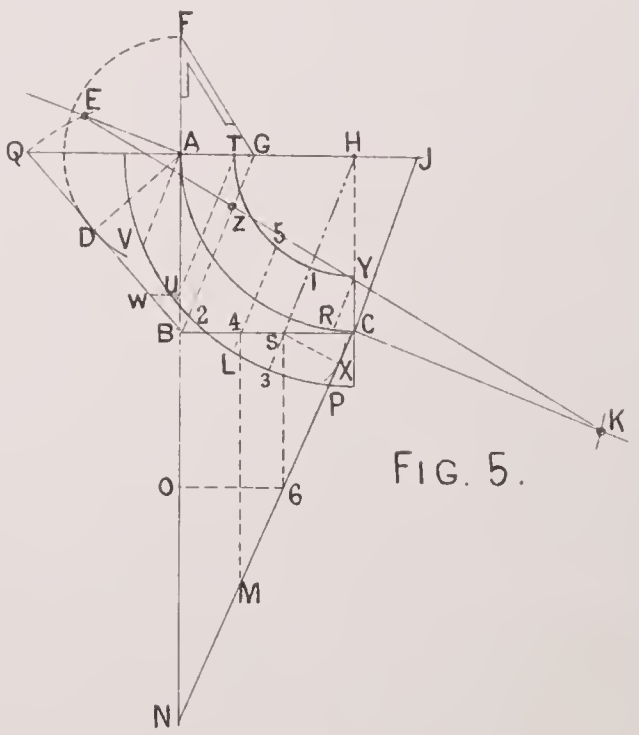


FIG. 5.

SCALE 1½ IN. = 1 FT.

PLATE 28.

Fig. 1. Plan of the Top Portion of a Winding Staircase Making a Half-turn with a 10″ Cylinder as given at Plate No. 6, Fig. 2.—Let A C B be the centre line of rail around the plan of cylinder, and A E, E D and D B tangents. Prolong E D to T indefinitely; prolong F C to J, A E to L, and F A to R, all indefinitely. Space the balusters on the centre line as shown. Further heights and inclination of tangents to be shown in connection with this plan, including measurements that are necessary to develop the centre line of wreath and at the same time fix the lengths of balusters, will be obtained after drawing the elevation.

Fig. 2. Elevation of Treads and Rises as Figured and as Taken from Fig. 1, the Plan.—The treads in the cylinder must be measured around the centre line of rail, and each tread taken in two parts to get a nearer stretch-out of the circular line. Draw the centre line of level rail $5\frac{1}{8}''$ above the floor. To fix heights and inclination of tangents, try a straight-edge in determining W and B, points on the upper and lower chord-lines; the points W and B are not fixed, but may be raised or lowered along the chord-lines at pleasure, taking notice, however, that if B is raised it will increase the length of ramp; also if W is raised the line R O will be shortened, a reasonable length of which is required to form the level easing as shown. At B draw B Y at right angles to the chord; set off four times $5\frac{5}{8}''$, the lengths of the tangents B D, D C, C E and E A of Fig. 1. Through each of these points of division draw lines parallel to the rises; from W parallel to the line of floor draw W R; connect R B and prolong to O, and B to F indefinitely. Where the line R B cuts the vertical lines at T, J and L, draw the lines T C, J E and L A at right angles to the rise-lines. Let B F at the ramp and the same distance R E at the level easement be the allowance for straight wood to be left on those ends of the wreath. At Fig. 1 make D T, C J, E L, and A R each equal D T of Fig. 2. Connect T B, J D, L C and R E.

To Prepare for and Develop the Centre Line of Wreath.—At Fig. 1 draw G N and S P parallel to F E; parallel to A B draw 2 H and P Q; parallel to C J draw Z K and N M. At Fig. 2 place the centres of balusters 5, 4 U G S on the treads as at the plan, and through each of these centres draw lines parallel to the rise-lines indefinitely; at baluster 5 make 2 H equal 2 H of Fig. 1; at baluster 4 make 8, 6 equal D T of Fig. 1; at baluster U make Z K equal Z K of Fig. 1; at baluster G make N M equal N M of Fig. 1; at baluster S make P Q equal P Q of Fig. 1. Through B H 6 K M Q W trace the centre line of wreath. The dotted lines are the top and bottom of the wreath set off from the centre line.

To Find the Lengths of Balusters Around the Wreath:—Take for example the baluster at U. U V is $1\frac{1}{2}''$, which added to the usual height of baluster at X, $2'.2''$, makes the height of this baluster on its centre line from the top of step to under side of wreath $2'.3\frac{1}{2}''$.

Fig. 3. Plan of Hand-rail from the Quarter-circle B C of Fig. 1 with the Tangents B D and D C.—Let the angles D T B and C J D equal the same at Fig. 1; connect F D; parallel to F D draw N R; parallel to C J draw V L; through B and C draw B P indefinitely; on D as centre with D J as radius describe the arc J P.

To Find the Angle with which to Square the Wreath-piece at Both Joints:—Prolong D C to Y; make C Y equal C W; connect Y F: then the bevel at Y will give the angle required.

Fig. 4. Face-mould from Plan Fig. 3; also Showing the Squaring of the Wreath-piece at Both Joints.—Let Z P, Z P each equal Z P of Fig. 3; make Z D at right angles to Z P and equal to Z D of Fig. 3; connect D P and D P; make D L, D L each equal D L of Fig. 3. Through L and L draw N R, N R parallel to Z D; make L R and L N each equal V R and V N; make Z O and Z S equal Z O and Z S of Fig. 3; through P and P draw N H, N H; make P H and P H each equal P N; prolong D P to F; make P F equal B F or R E of Fig. 2. The joints F and P are made at right angles to the tangents. Make N A and N A each parallel to the tangents. Through H R D R H of the convex and N S A of the concave trace the edges of the face-mould. The bevel at Y and Y, used to square the wreath-piece at both joints as shown, is taken from Y of Fig. 3. One face-mould (Fig. 4) in this case answers for both wreath-pieces. The joint F joins the ramp at F, and the same joint joins E, the level easement at the top. This face-mould is explained in detail at Plate No. 11. The development of the centre line of wreath is explained in detail at Plate No. 20, Figs. 1 and 2, by repeating the first quarter A C, Fig. 1, and the development A E of Fig. 2 of that Plate. *Sliding face-moulds and squaring wreath-pieces are given at* Plate No. 56.

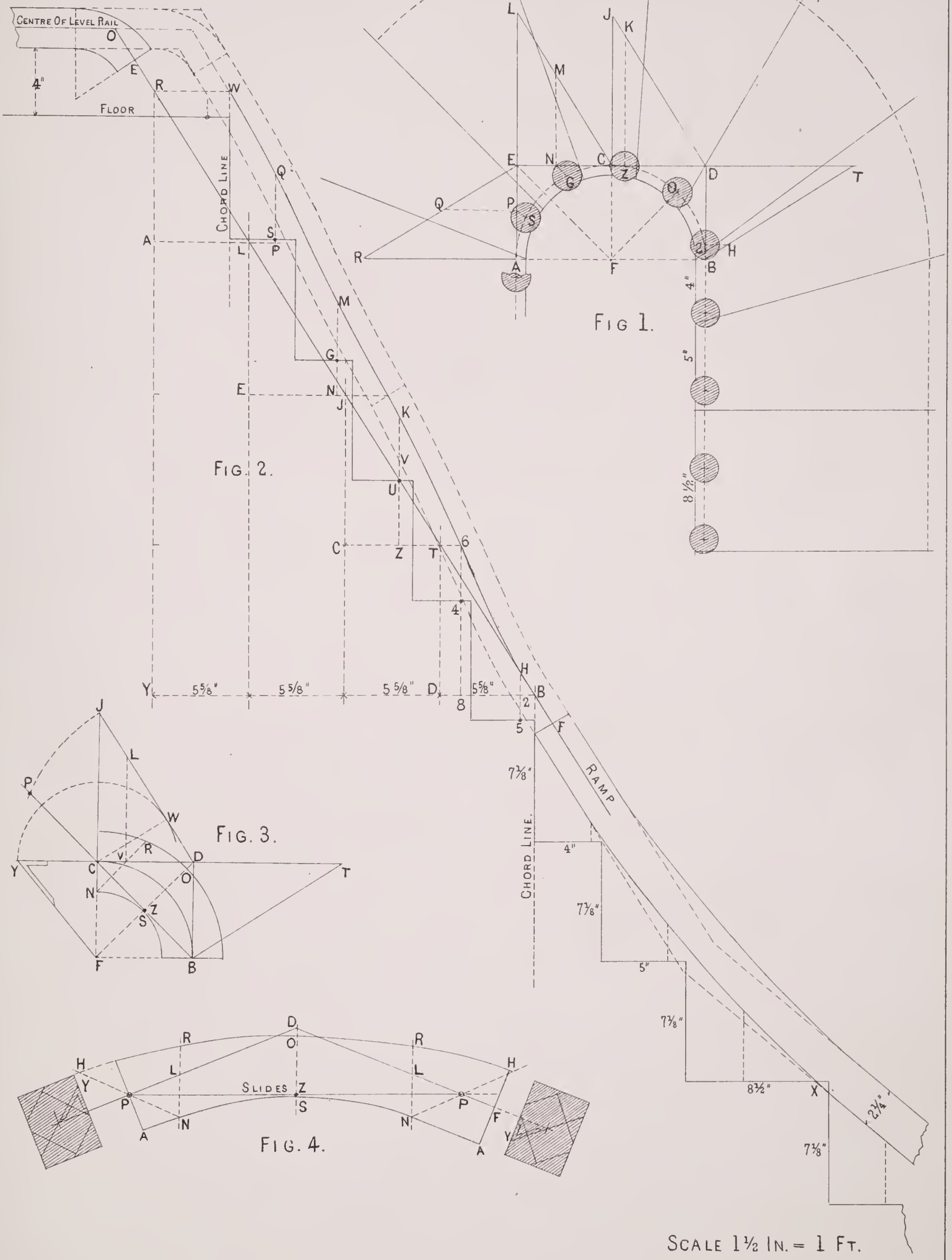


FIG. 2.

FIG 1.

FIG. 3.

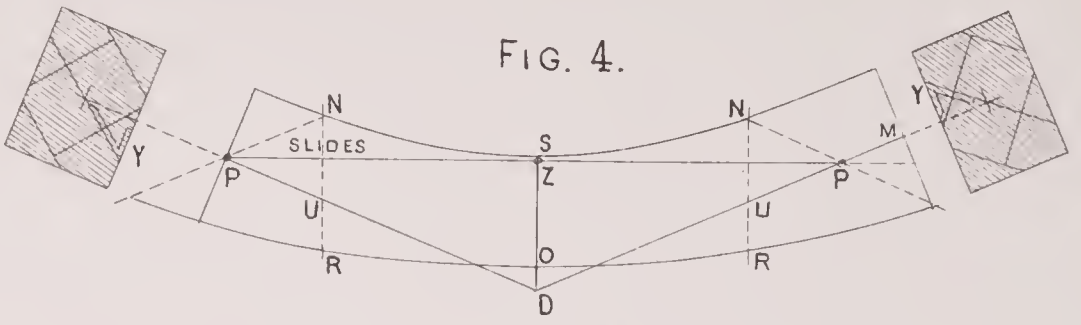
FIG. 4.

SCALE 1½ IN. = 1 FT.

PLATE 29.

Fig. 1. Plan of the Bottom or Starting Portion of a Winding Staircase making a Half-turn with a 10″ Cylinder as given at Fig. 2, Plate No. 6.—As this case is the same as the one already given at PLATE No. 28 with the exception of position, that being the top and this the bottom of a flight exactly alike in plan, there seems to be no need of repeating what has just been given in minute detail; but the plan, the elevation, etc., serve a most useful purpose in showing at a glance such differences as are naturally caused by the changed position of the same plan: such as the length of ramp (which at the bottom of a flight is shorter); also the lengths of balusters if required. But there need be no change of face-mould if care is taken in keeping the inclination of tangents alike. It will be seen upon examination that all measurements required at FIG. 2 are taken from FIG. 1, or the reverse; those measurements taken from FIG. 2 as required at Fig. 1 are lettered or figured alike. The lettering likewise agrees between the quarter B C of FIG. 1 and the plan of hand-rail FIG. 3. Also as far as possible the lettering is alike between the plan of hand-rail FIG. 3 and the measurements to be taken in connection with it for drawing the face-mould and squaring the wreath-piece at FIG. 4.

FIG. 4.



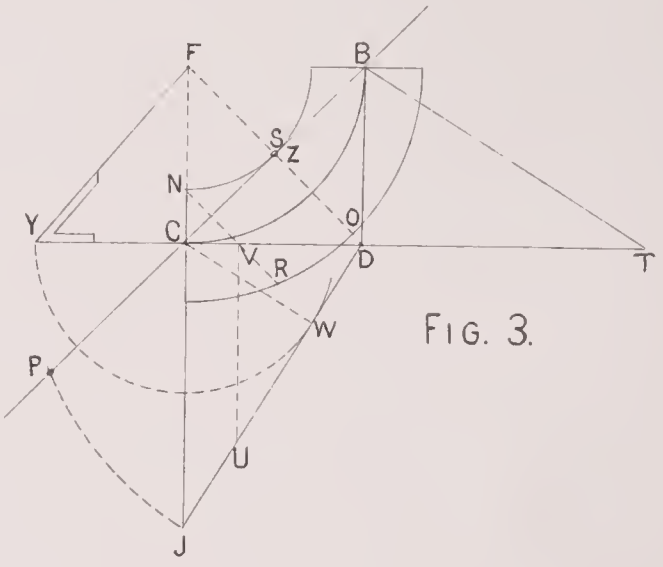


FIG. 3.

FIG 2

FIG 1.

SCALE 1½ IN. = 1 FT.

PLATE 30.

Staircases are frequently planned of greater width at the starting by curving the front-string out, embracing in the curve from one to five treads; the least curve including but one step is done merely to save the width of stairs at this point by setting the newel-post a few inches aside. The larger curves including more steps give the stairs an inviting and more ornamental appearance. There is also a more recent practice of setting the newel on top of the first step by extending this step and riser in a curve sufficient to include the curve-out and the base of the newel as shown at FIG. 3. This gives in very little space a neat and elegant finish at the starting of a staircase.

Fig. 1. Plan of Curve-out in One Tread, together with Sufficient Elevation for those Measurements Required to Fix the Height of Newel and Draw the Face-mould or Parallel Pattern.—Let the bottom of rail rest on the centres of the short balusters at X X; make R T equal 6″, and T L half the thickness of rail; let L N be the centre line of rail; draw L M at right angles to the rise-line; parallel to the rise-line draw L A: then A at the plan on the centre-line of rail C A becomes a fixed point from which the tangent A B may be drawn at pleasure. Make C F equal M N; connect F A; from any point on the centre curve S draw a line parallel to A B touching the line C A at Z; draw Z O parallel to C F; at right angles to A B draw C D indefinitely; on A as centre with A F as radius describe the arc F D; connect D B.

To Find the Angle with which to Square the Wreath-piece at the Joint over B:— Parallel to A B draw C K indefinitely; at right angles to A B draw B J; make J K equal C F; connect K B: then the bevel at K will give the angle sought.

To Find the Angle with which to Square the Wreath-piece at the Joint over C:— Prolong the tangent B A to G, and the tangent A C to H, indefinitely; make C H equal C E; connect H G: then the bevel at H will give the angle required.

Fig 2. Parallel Pattern for Wreath-piece from the Plan Fig. 1.—Make A O V F equal the same letters at FIG. 1. On F as centre with D B of FIG. 1 as radius describe an arc at B; on A as centre with A B of FIG. 1 as radius intersect the arc at B; connect B A; make B T equal B T of FIG. 1; through T at right angles to A B draw Y Z; draw O S parallel to A B; make O S equal Z S of FIG. 1. The width of the rail being 3″, the parallel pattern will be $3\frac{3}{4}$″. Make V P and V Q each $1\frac{7}{8}$″; parallel to V F draw P G and Q E; make B L and B W each $1\frac{7}{8}$″; parallel to B A draw L Z and W Y; on S as centre with $1\frac{7}{8}$″ as radius describe a circle and sketch the curves P Z and Q Y touching the circle. The angle for squaring the wreath-piece at joint B is taken by the bevel K at FIG. 1, and for the joint F the bevel H of FIG. 1.

Fig. 3. Plan and Elevation of the Starting of a Staircase with the Front-string Curved Out and the Newel Set on Top of the First Step; the Elevation and Plan Prepared, Fixing the Height of Hand-rail at the Newel, and for Drawing the Face-mould.—Let the bottom of rail rest on X X, the centres of short balusters, and make A B, the centre line of rail, parallel to X X; make D E equal 8″, and E F half the thickness of rail; draw F C parallel to the line of tread; draw A G parallel to the line of riser: then G becomes a fixed point on the line of tangent V G from which the level tangent G J Z must be drawn, but may be kept any distance from I to Z at pleasure. Parallel to Z G draw H O and L K; parallel to V M draw O S and K W; from V at right angles to G J draw V N indefinitely; on G as centre with G M as radius describe the arc M N; connect N J.

To Find the Angle with which to Square the Wreath-piece at the Joint over J:— From V parallel to G Z draw V R indefinitely; draw J T at right angles to J G; make T R equal V M; connect R J: then the bevel at R will give the angle sought.

To Find the Angle with which to Square the Wreath-piece at the Joint over V:— Prolong Z G to U, and G V to P, indefinitely; make V P equal V Q; connect P U: then the bevel at P will give the angle required.

Fig. 4. Parallel Pattern for Wreath-piece from the Plan Fig 3 —As this rail is to be 4″ wide by $2\frac{1}{2}$″ thick, the pattern will answer to get out the wreath-piece if $4\frac{3}{4}$″ wide. Draw the line G A; make G M equal G M of FIG. 3. Let M A equal 5″ more or less for straight wood; on M as centre with N J of FIG. 3 as radius describe an arc at J; on G as centre with G J of FIG. 3 as radius intersect the arc at J; connect J G; make W L equal K L of FIG. 3; make S H equal O H of FIG. 3. With $2\frac{3}{8}$″ radius describe circles from the centres J, H, L, M and A; connect B F and C E. The joints J and A are made at right angles to the tangents. Bend a flexible strip of wood touching the circles on the convex and concave and mark the curved edges of the pattern. The angle for squaring the wreath-piece at joint J is taken by the bevel at R of FIG. 3, and for the joint A by the bevel at P of FIG. 3. The height of hand-rail from the top of the second step, D, to the bottom of the rail, E, will equal—by adding the height of short baluster at X, which is 2′.2″, to the 8″ raised between D and E—2′.10″. Face-mould for FIGS. 1 or 3 is treated in detail by PLATE No. 13. *One feature of this plan given at* FIG. 3 *which is open to objection is the increased height of newel; how to reduce this, if required, will be shown by the following* PLATE, No. 31.

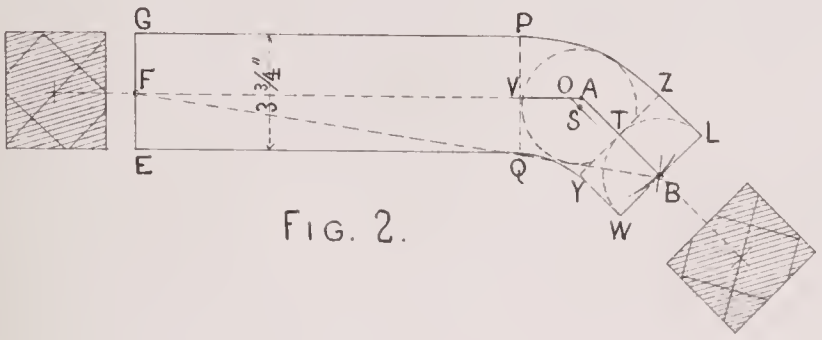


FIG. 2.

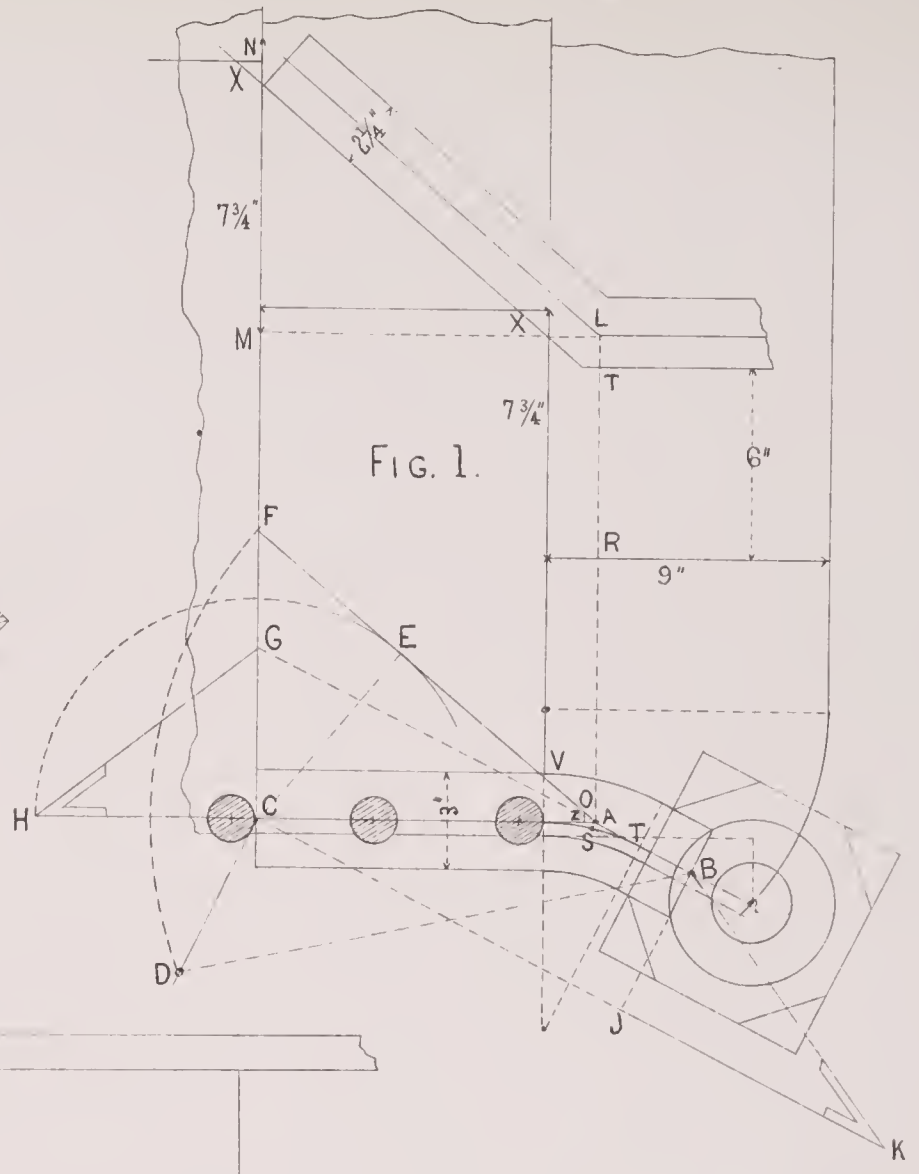


FIG. 1.

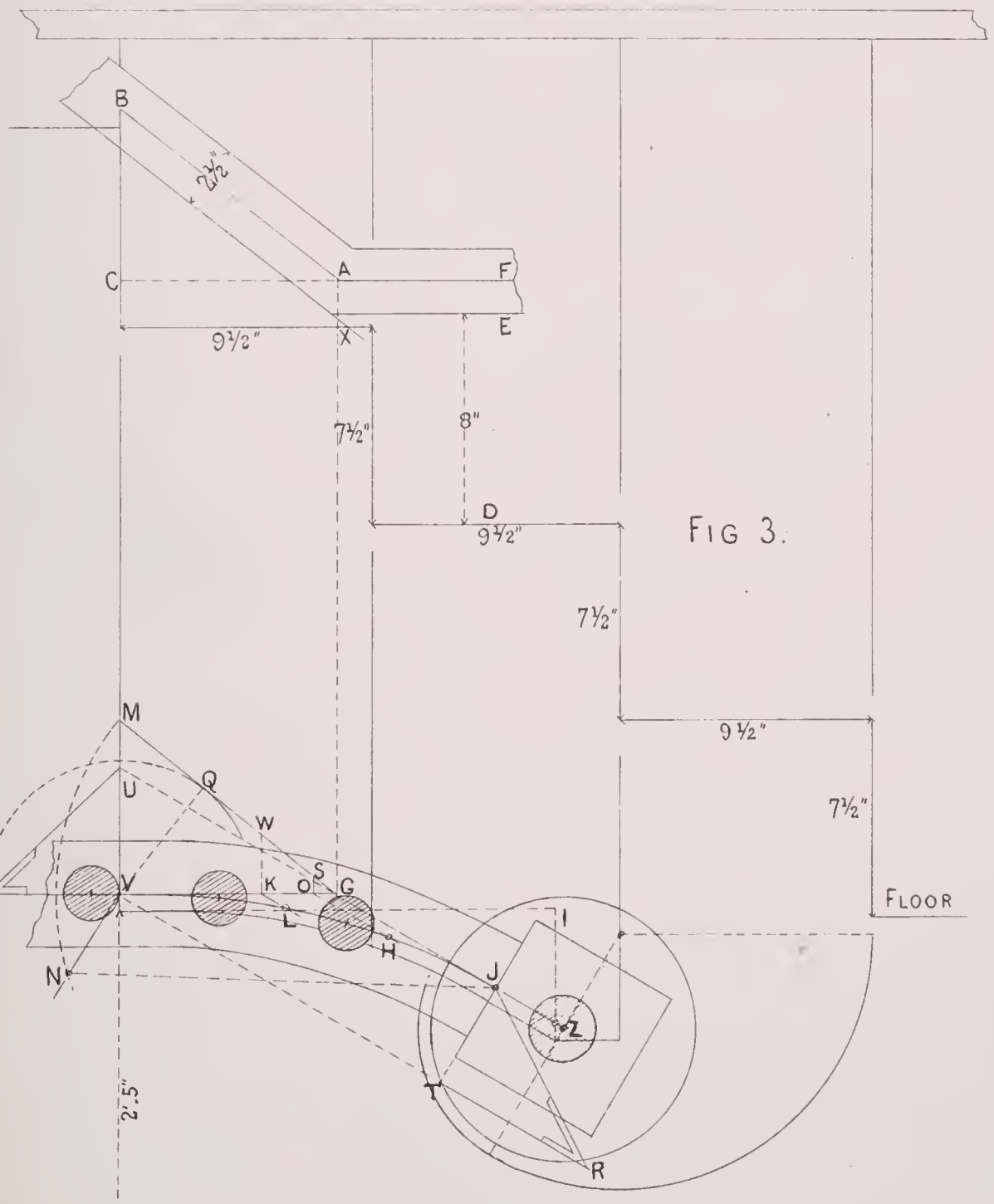


FIG 3.

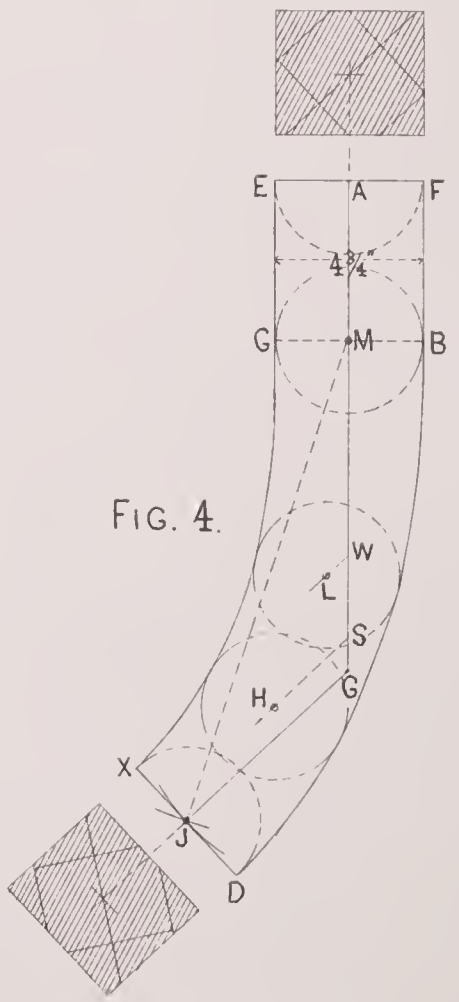


FIG. 4.

SCALE 1½ IN. = 1 FT.

PLATE 31.

Fig. 1. Plan and Elevation of the Starting of a Staircase with the Front-string Curved Out and the Newel Set on Top of the First Step, the Elevation and Plan Prepared to Continue the Hand-rail on a Common Inclination to the Newel, and for a Face-mould as Required.—Let the bottom of the rail rest on X X the centres of short balusters; draw the centre line of rail Z R parallel to X X; make the tangents C V and V P of equal lengths; from V parallel to the rise-line draw V 5; parallel to the tread-line draw 5 Y; make 4 R equal V P; through R parallel to V 4 draw W 8; at R draw R 4 at right angles to V 4; draw R U at right angles to R 5; make C G equal Y Z; connect G V; make V B equal 4, 5 and at right angles to V P; connect B P; through C draw P D indefinitely; on V as centre with V G as radius describe the arc G D; at right angles to D P, through V draw Q O, F N M and T L; at right angles to C V draw A K and L J.

To Find the Angle with which to Square Both Ends of the Wreath-piece:—Parallel to C V draw K I; at right angles to G V draw I H; prolong C V to E indefinitely; make C E equal I H; connect E F, then the bevel at E will give the angle required.

Fig. 2. Face-mould from Plan, Fig. 1; also Squaring the Wreath-piece at Both Joints.—Draw the line D D; make S D, S D each equal S D of Fig. 1; at right angles to D D through S draw Q O; make S V equal S V of Fig. 1; connect V D and V D; make V K J and V K J each equal V K J of Fig. 1. At right angles to D D through J K and J K draw T J, N M, N M and T J; make J T and J T each equal L T of Fig. 1; make K M, K N and K M, K N each equal A M and A N of Fig. 1; make S O and S Q equal S O and S Q of Fig. 1; through D draw T Z at both ends; make D Z and D Z each equal T D. The lower end of the wreath-piece requires an addition of straight wood to fill out the plumb joint as shown at 6 U of the elevation, Fig. 1. Make D F equal 6 U of Fig. 1; make D U equal 4″, more or less for straight wood; parallel to V U draw Z B and T A. The joints U and F are made at right angles to the tangents. Through Z M O M Z of the convex and T N Q N T of the concave trace the curved edges of the face-mould. The angle for squaring the wreath-piece at joints F and U is taken by the bevel at E, Fig. 1. This case of face-mould is treated in detail at Plate No. 15. The difference in height between this manner of treating the hand-rail and that of Fig. 3, Plate 30, is from the top of the rail at 8, where it joins the newel in that case, to the top of the rail at 2, where it joins the newel in this case, just 6″. When the rail is set up at X X, 2′.2″, the height of rail from W to 2 will be 26′.½″, and between those points at Fig. 3, Plate 30, the height is 3′.½″. Much more than 6″ can be gained if desired by moving the centre of the newel further towards the first riser on the line 3, 3 and increasing the radius of the curve-out to suit the change. This might be very desirable in case of designing with this style of finish a low newel.

Fig. 3. Plan of a Quarter-platform Stairs with a Quarter-cylinder of 8″ Radius, the Risers each Set at A and B, the Chord-lines.—Let A Z B be the centre line of rail on the plan; divide the quarter-circle A B at Z in exactly two equal parts; connect 6 Z; at right angles to 6 B draw B E indefinitely; through A at right angles to 6 A draw T H Y indefinitely; through Z at right angles to 6 Z draw H E; make A Y equal 9″, one tread; at right angles to A Y draw Y P; make Y P equal 8″—the rise; connect P A; parallel to Y P draw H K; parallel to AY draw K L; make L M equal Y L; divide P M in two equal parts at N; make H J equal M N; draw J W parallel to Y A; draw W X parallel to 5 A; from A draw A R parallel to the tangent H Z; make A R equal the tangent H Z; connect X R, which is the level line. Through H draw 5 G parallel to X R; anywhere on the centre curve-line draw the line 2 U parallel to X R; from A at right angles to X R draw A Q indefinitely; on the dividing radial 6 D make Z D equal M N; connect D H; from Z at right angles to H G draw Z I indefinitely; on H as centre with H D as radius describe an arc cutting the line Z I at C; on H again as centre with K A as radius describe an arc cutting the line A Q at Q; connect Q C.

To Find the Angle with which to Square the Wreath-piece at the Joint over Z:—Make Z F equal Z O; connect F G; then the bevel at F will give the angle sought.

To Find the Angle with which to Square the Wreath-piece at the Joint over A:—Make A T equal H V; connect T 5; then the bevel at T will give the angle required.

Fig. 4. Parallel Pattern for Wreath-piece from the Plan Fig. 3.—Draw the line Q C, and make Q 4 C equal the same at Fig. 3. On Q as centre with A K of Fig. 3 describe an arc at K; on C as centre, with D H of Fig. 3 as radius, intersect the arc at K; also 4 K will equal 4 H of Fig. 3. Connect Q K, K C and 4 K; make K 3 equal H 3 of Fig. 3; make Q V equal A V of Fig. 3; draw V 2 parallel to K 4; make V 2 equal U T of Fig. 3; make Q B equal 3″, or more for straight wood. The size of this rail is to be $2\frac{1}{4}$″ thick by 3″ wide, therefore the parallel pattern will require to be $3\frac{3}{4}$″ wide. With $1\frac{7}{8}$″ as radius on C, 3, 2, Q, B as centres, describe circles. Make a line touch these circles for the concave and convex edges of the pattern. The joints B and C are made at right angles to the tangents. The angle for squaring the wreath-piece at joint C is taken by the bevel at F of Fig. 3, and for the joint B by the bevel at T of Fig. 3. The slide line is drawn at right angles to the level line 4 K. This pattern serves for both wreath-pieces, C being the centre joint. A face-mould of this kind is treated in detail at Plate No. 16. This quarter-cylinder with its connecting steps and risers should be planned in such a way that the quarter-wreath could be got out in one piece of a common inclination as shown at Plate No. 37, Figs. 5, 6 and 7. It would cost less and be a superior-shaped wreath-piece.

SCALE 1½ IN. = 1 FT.

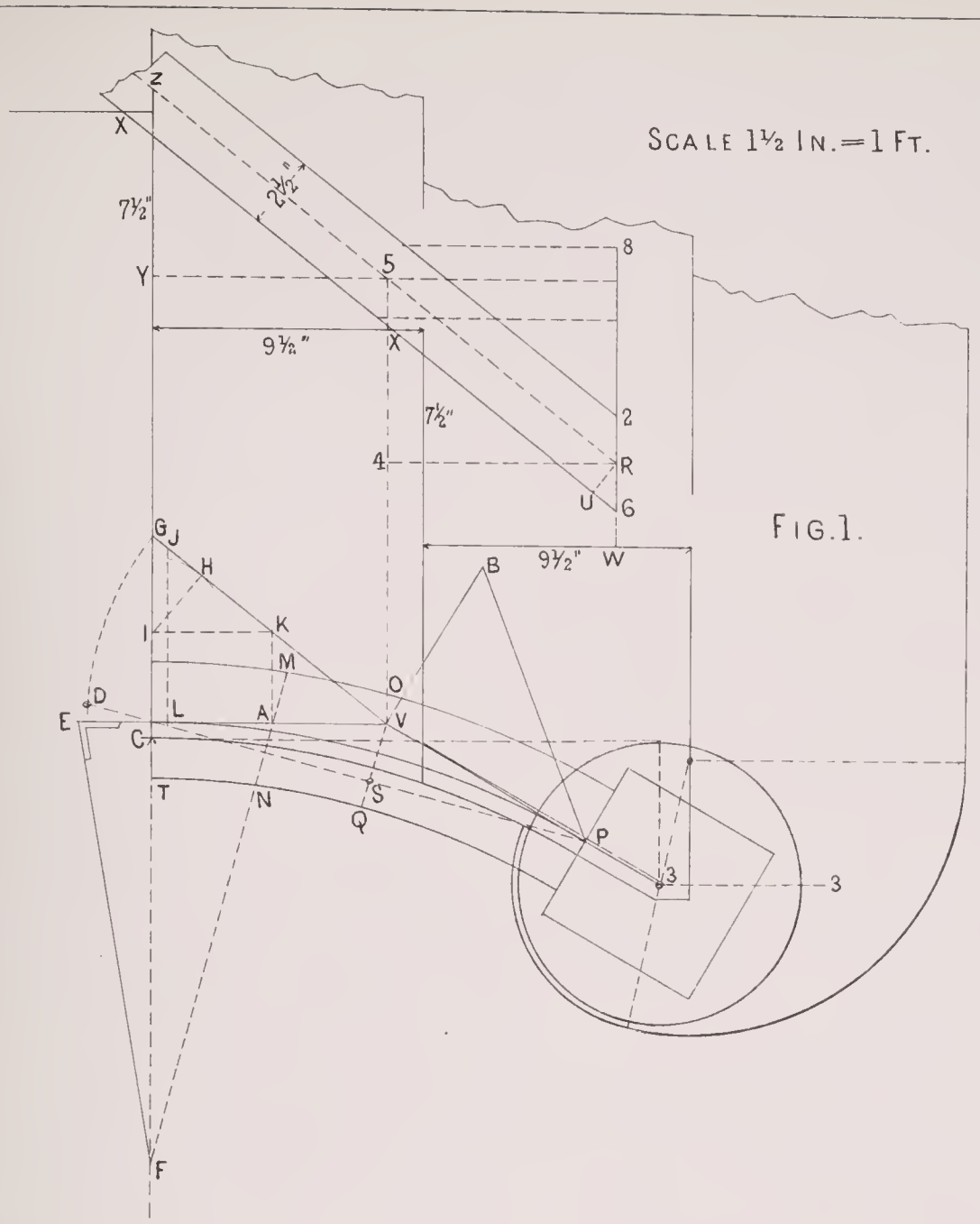


FIG. 1.

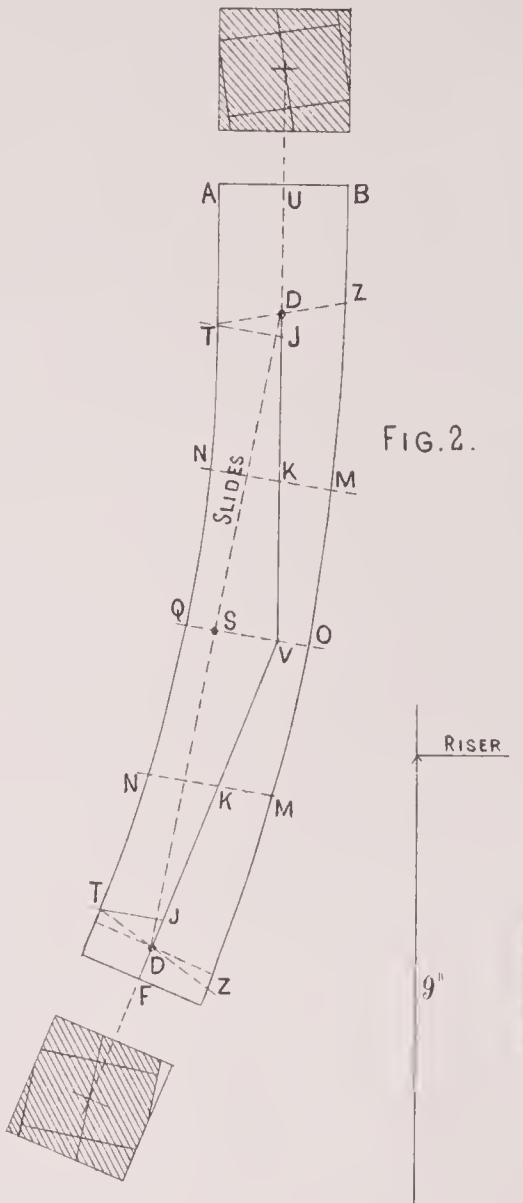


FIG. 2.

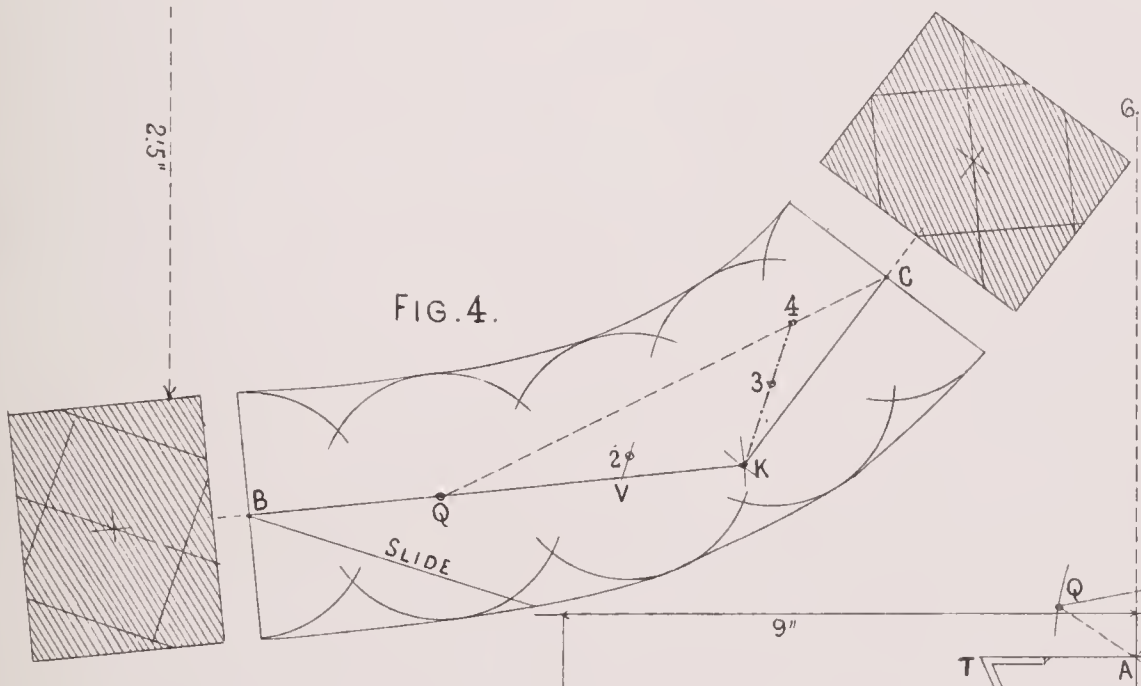


FIG. 4.

FIG. 3.

SCALE 3 IN. = 1 FT.

PLATE 32.

Fig. 1. Plan of Hand-rail composed of Two Curves of Different Radius as a Curve-out at the Starting of a Staircase, taken from the Plan given at Fig. 5, Plate No. 6.—This shape of curve is a necessity in order to make a proper connection with a square newel where the sides of the newel are required to be set parallel to the sides of the hallway, as shown by the plan above mentioned. An elevation has to be set up in order to fix the length of plan tangent D F, as at A C of Fig. 2. And the greater the required height of newel the higher up the line A C must be placed, and therefore the shorter this line and the plan tangent will be.

Fig. 2. Elevation of Tread and Rise as at Plan of Hand-rail Fig. 1, taken from Fig. 5 of Plate No. 6.—Let the bottom line of rail pass through X X, the centres of the short balusters of the regular tread; make L Q $5\frac{1}{2}''$, more or less, depending on what height of newel is demanded; make Q V half the thickness of rail; draw V C A parallel to the line of treads; let C B be the centre line of rail parallel to X X. When the hand-rail is set up, the height from the top of the first step, L, to the bottom of the rail, Q, will be $2'.2''$ at X and $5\frac{1}{2}''$ more at L O, equal to $2'.7\frac{1}{2}''$. At Fig. 1 make D E equal A B of Fig. 2; connect E F; parallel to D E draw H T, I U, J V, K W and L Y.

Fig. 3. Face-mould to be taken from Plan Fig. 1; also Squaring the Wreath-piece at Both Joints.—Make F T U V W Y E equal the same at Fig. 1; draw F G at right angles to F E; make F G equal F G of Fig. 1; through G parallel to F E draw A H; parallel to F G draw T H, U I, V J, W K, O L and N M; make G A equal G H. Set off all measurements from the line F E as taken on the line F D of Fig. 1 according to the corresponding letters at the curves. Through N O X X X X X A of the convex and M L K J I H of the concave trace the curved edges of the face-mould. The bevel at E of Fig. 1 is used to square the wreath-joint G of Fig. 3. It would be well to add about $3''$ for straight wood to joint E.

Fig. 4. Plan of the Starting Portion of a Staircase with the Front-string Curved Out, and Embracing Four Treads of Equal Widths at the Wall-string and Front-string.—At the elevation, Fig. 5, the bottom line of rail rests at X X, the centres of short balusters; B C and D C are the centre lines of rail. Fixing the point C controls the height of rail at the newel; also the length of tangent A C at Fig. 4. F E being $9''$, add that to the height of short baluster at X, $2'.2''$, and the sum $2'.11''$ will be the height between F and E. In a flat curve like this it is desirable to keep the point C up as high as can be allowed, for it shortens the tangent A C, Fig. 4, and makes the bevel line C O more nearly a tangent. Let the angle A B C equal the same at the elevation; connect C O; parallel to C O draw 4 W, I V, Q U, R G, 8 K and A M; parallel to A B draw J H, S V, U Z, 3 Y and 8 X. From A draw A 9 at right angles to O C; on C as centre with C B as radius describe the arc B 9; connect 9 O.

To Find the Angle with which to Square the Wreath-piece over the Joint A:—Draw S 6 parallel to C B; prolong C A to L; make A L equal A 6; connect L G: then the bevel at L will give the angle sought.

To Find the Angle with which to Square the Wreath-piece over the Joint O:—Make 2 M equal A B; connect M O: then the bevel at M will give the angle sought.

Fig. 6. Face-mould from Plan Fig. 4; also Squaring the Wreath-piece at Both Joints.—Let O B equal O 9 of Fig. 4. On B as centre with B C of Fig. 4 as radius describe an arc at C; on O with O C of Fig. 4 as radius describe an intersecting arc at C; connect O C and C B; make the spaces lettered on B C agree with those of B C at Fig. 4; parallel to O C draw X J, Y I, Z Q, V T R and H W: take all measurements on the tangent A C, Fig. 4, and set them off from the line B C as shown by the corresponding letters; make O N equal O J; through B draw W K; make B K equal B W; prolong C B to A; make B A $4''$ for straight wood. The joints A and O are at right angles to the tangents. Through W T 5 F E P N of the convex and K R Q I J of the concave trace the curved edges of the face-mould. The angle for squaring the wreath-piece at joint O is taken by the bevel M at Fig. 4, and that for joint A by the bevel L at Fig. 4. Face-mould Fig. 3 is treated in detail at Plate No. 10, and face-mould Fig. 6 is treated likewise at Plate No. 13.

Note.—The line **O C** of Figs. 4 and 6 is not a tangent, but is simply a level line used to fix the height, control the joint, and to guide the measure, or drawing, of the face-mould. *Care should be taken in laying out the squaring at joint* **O** *of the wreath-piece that the width of rail be made equal to* **J N** *of* Fig. 4, *because, although* **J N** *is at right angles to* **O C**, *it is oblique to the curve, and may, therefore, measure a quarter of an inch or more over the width of rail.* After the wreath-piece is squared at the joint **O**, a portion of the wood, equal to **N U J** of Fig. 4, is cut away to correct that joint.

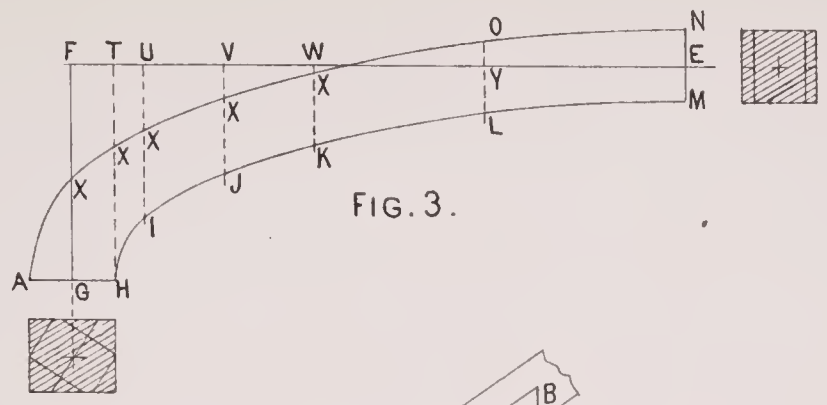


FIG. 3.

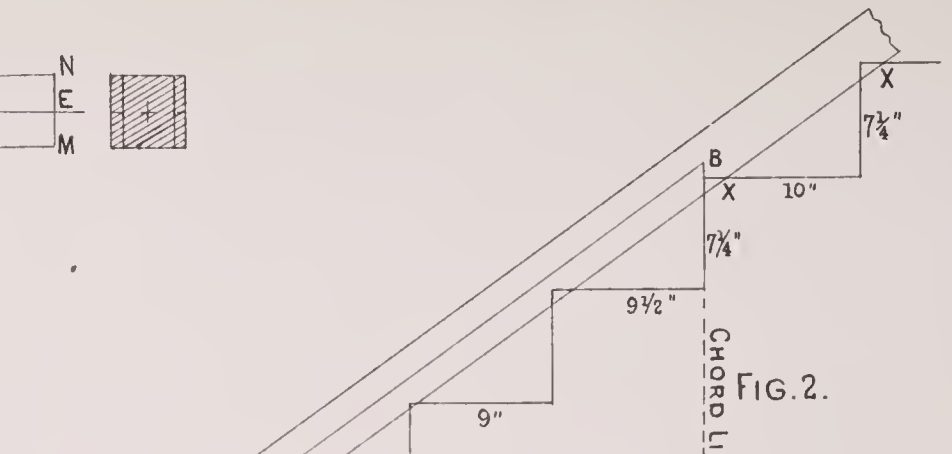


FIG. 2.

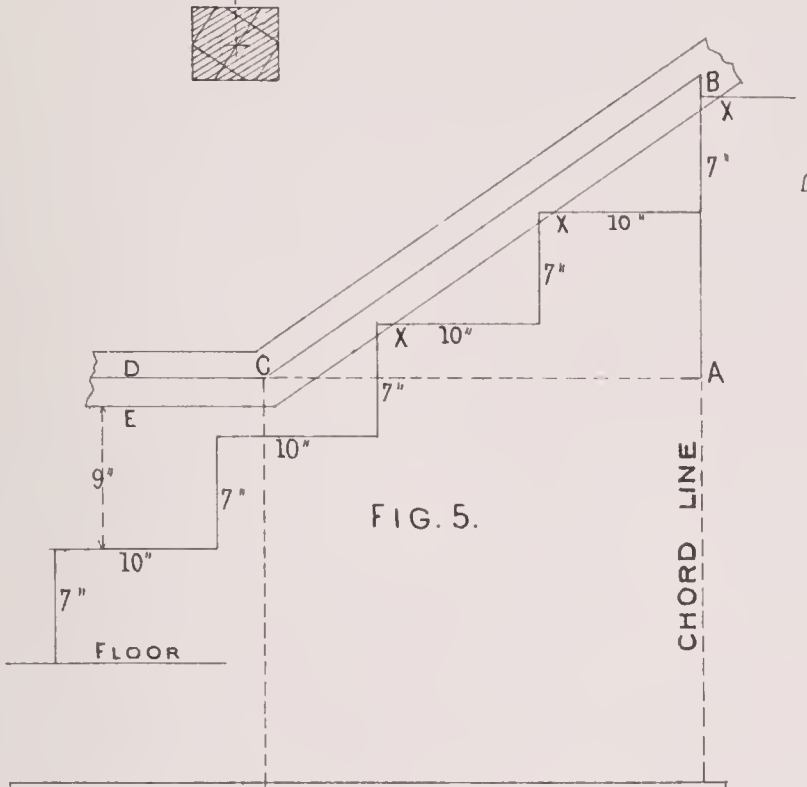


FIG. 5.

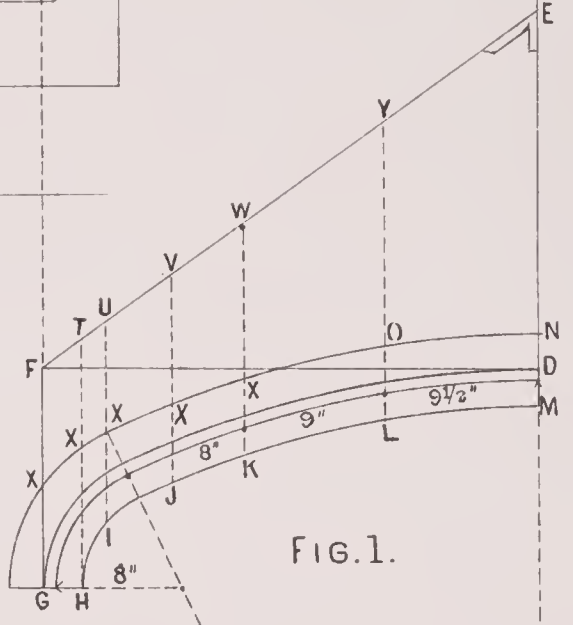


FIG. 1.

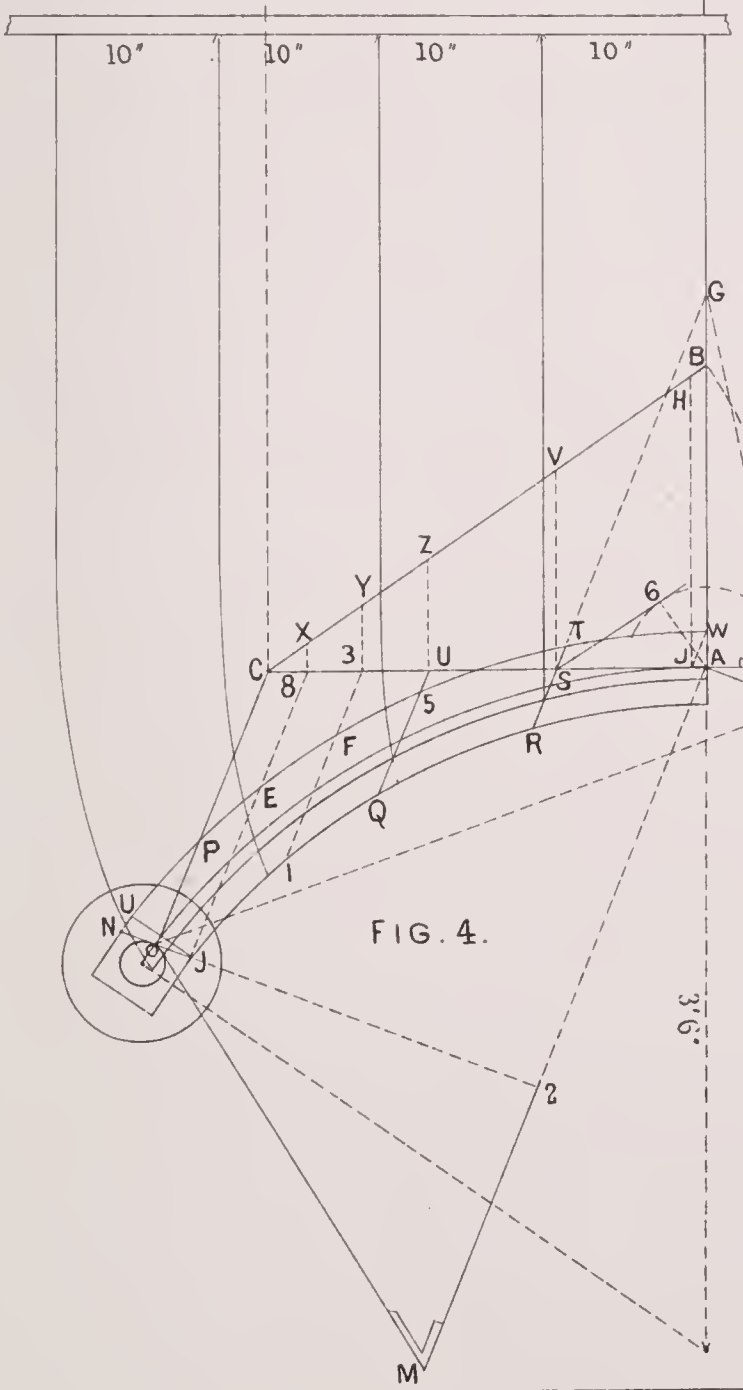


FIG. 4.

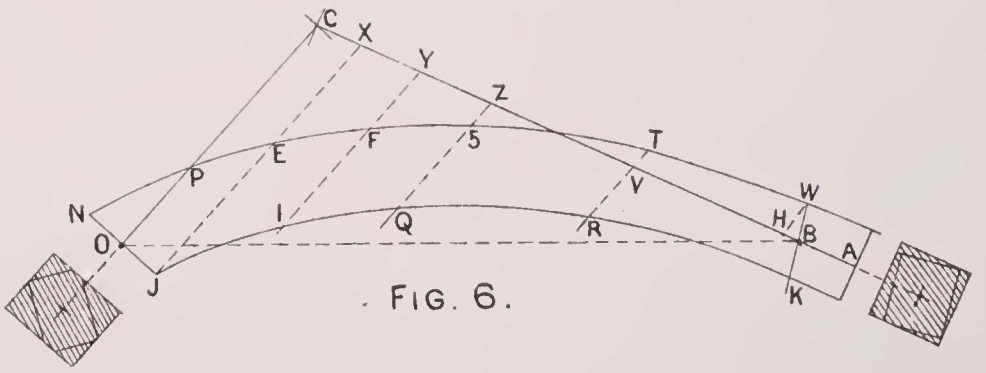


FIG. 6.

5'0"

SCALE ¾ IN. = 1 FT.

PLATE 33.

Fig. 1. Plan of the Landing Portion of a Straight Flight of Stairs with the Top Riser Set in the Whole Depth of a Ten-inch Cylinder, thereby Saving Five Inches Space.—The plan made as described with the addition of the plan and centre line of rail, *proceed to set up the elevation*, FIG. 2, resting the bottom line of rail on the centres X X of the short balusters, and the centre of rail A D in position parallel to X X, the point D being fixed by the level line G D, and its height F G from the floor. The point A is decided by the position of the chord-line as taken from the plan; A C is drawn parallel to the line of tread. This completes the preparation of the elevation, all being obtained that is required in fixing the point A and D together with the height C D. Again at FIG. 1, parallel to the line of string, let the line F A pass through C, the centre of rail; make C D at right angles to C A, and C D A equal to C D A of FIG. 2. From A draw the line A I touching the centre line of rail at Q; the exact place of Q is determined by drawing a line from the centre O, at right angles to A Q; parallel to A Q draw R Y, S X, V W H J and P U; parallel to C D draw T 2, N M, X 3 and Y Z; from C at right angles to A Q draw C E; on A as centre describe the arc D E; connect E Q.

To Find the Angle with which to Square the Wreath-piece at the Joint over Q:— Anywhere along the line W J draw H I parallel to O Q. Make H J equal N M; connect J I; then the bevel at J will give the angle sought.

To Find the Angle with which to Square the Wreath-piece at the Joint over C:— From M parallel to A C draw M K; make C F equal K L; connect F G; then the bevel at F will give the angle required.

Fig. 3. Face-mould from Plan Fig. 1, also showing the Squaring of the Wreath-piece at Both Joints.—Draw the line D Q indefinitely; make D Q equal E Q of FIG. 1. On D as centre, with D A of FIG. 1 as radius, describe an arc at A; and on Q as centre, with Q A of FIG. 1 as radius, intersect the arc at A. Connect A Q and A D; prolong A D to L and equal to A E of FIG. 2, or at pleasure for straight wood. Make D 2 M 3 Z the same as at the corresponding letters of FIG. 1. Parallel to A Q draw Z R, 3 S, M V W and 2 U P; through Q draw R C at right angles to A Q; make Q C equal Q R; make A 4 equal A 4 of FIG. 1; make 3, 5 S equal X 5 S of FIG. 1; make M V, M W equal N V, N W of FIG. 1; make 2 U, 2 P equal T U, T P of FIG. 1; through D draw P B; make D B equal D P; parallel to D L draw P E and B F; through C 4 5 V U B of the convex and R S W P of the concave trace the edges of the face-mould. The tangent Q A being a level line, the face-mould slides along the joint R C. The angle with which to square the wreath-piece at joint Q is taken by the bevel at J of FIG. 1, and for the joint L is taken by the bevel at F of FIG. 1. *This face-mould is treated in detail at* PLATE No. 14. The level portion of rail Q B may have as much straight wood attached to B as seems desirable.

Fig. 4. Plan of the Starting Portion of the Same Flight of Stairs given at Fig. 1 with a Ten-inch Cylinder, and the Starting Riser Set in the Whole Radius or Depth of Cylinder, Saving Another Five Inches.—Having made the plan as described, proceed to set up the elevation, FIG. 5. Let the bottom line of rail rest on the centres X X of the short balusters. Place the centre of the rail C B in position parallel to X X, the point C being fixed by the level line G C, and its height F G from the floor. The point B is fixed by the position of the chord-line as taken from the plan. A C G is drawn parallel to the line of floor. The place of B, the height A B, and the distance A C is all that is required of the elevation. Again at FIG. 4 prolong the diameter-line S A of the cylinder to B indefinitely; at the centre line of the rail A, at right angles to A B, draw A C; make A B C equal to A B C of FIG. 5. From C draw the line C D tangent to the centre line of the rail at the point D, to be determined by drawing a line from O at right angles to the tangent C D. The remaining portion of the rail D S is level, and at S straight wood can be added at pleasure. To draw the face-mould proceed as at FIGS. 1 and 3. It is necessary to give further attention to this case of hand-rail from the fact that although the riser is set in the cylinder the same at the bottom as at the top of the flight, there is a difference requiring another face-mould unless it is thought worth while to make the top face-mould answer also for the bottom. In the latter case let C stand exectly as it is, and make C L equal C A of FIG. 1 and L N equal C D of FIG. 1; then change the place of the chord-line—or commencement of the cylinder—to L, and describe the centre line of the rail from the new centre, and draw from C a new tangent, and the case will then agree with the top plan tangents and face-mould.

Fig. 6. Elevation Same as Fig. 5, for the Development of the Centre Line of Wreath from Plan, Fig. 4.—The corresponding letters and figures of FIGS. 4 and 6 will give a snfficient explanation. This development of the centre line of the wreath-piece is introduced to demonstrate the correctness of treating such cases in the manner here shown. Treating cases of hand-railing like this in two quarters—the joint in the centre—makes it necessary to square up both pieces and draw two face-moulds, with no better result and nearly double the cost. This face-mould, FIG. 3, is treated in detail at PLATE No. 14. The development of the centre line of wreath is given in detail at PLATE No. 21, FIGS. 1 and 2.

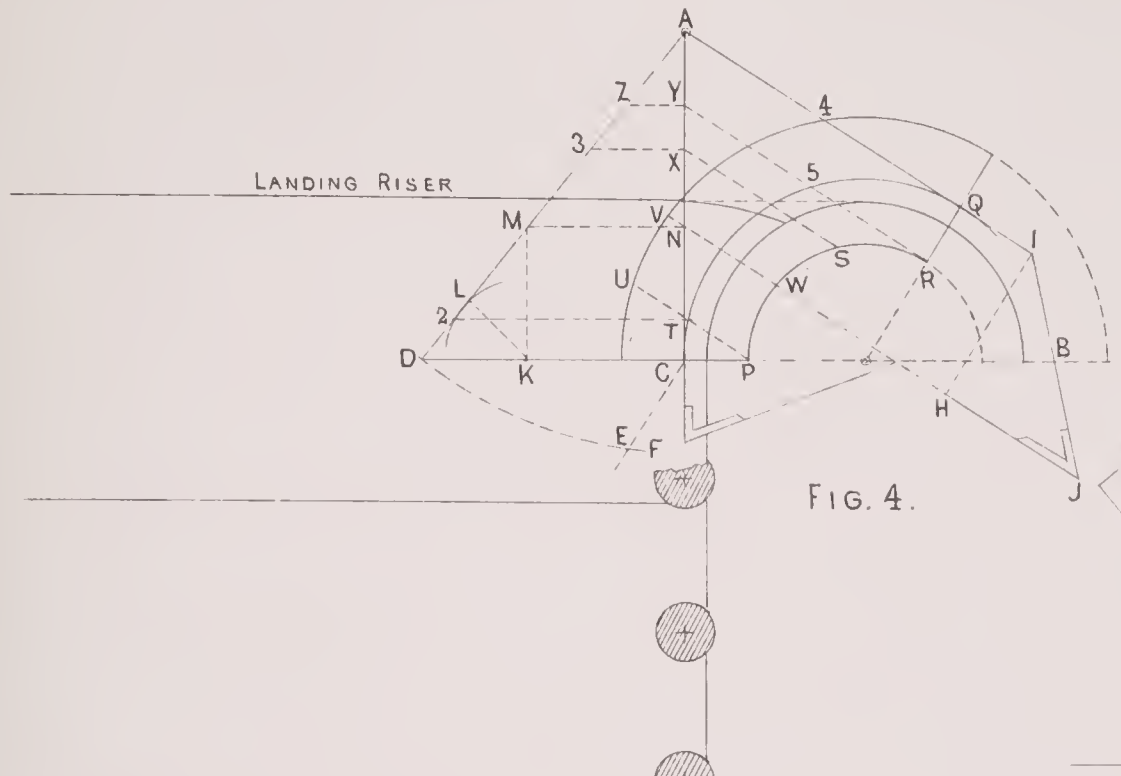


FIG. 4.

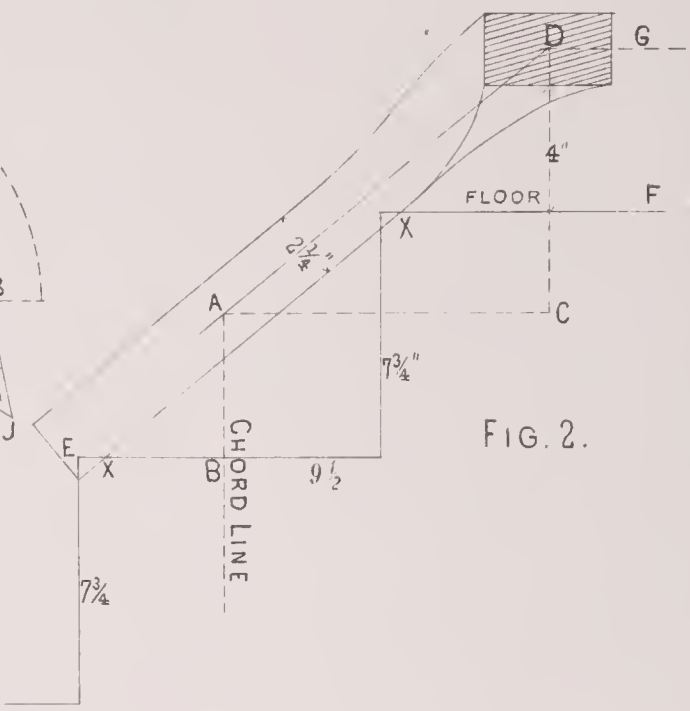


FIG. 2.

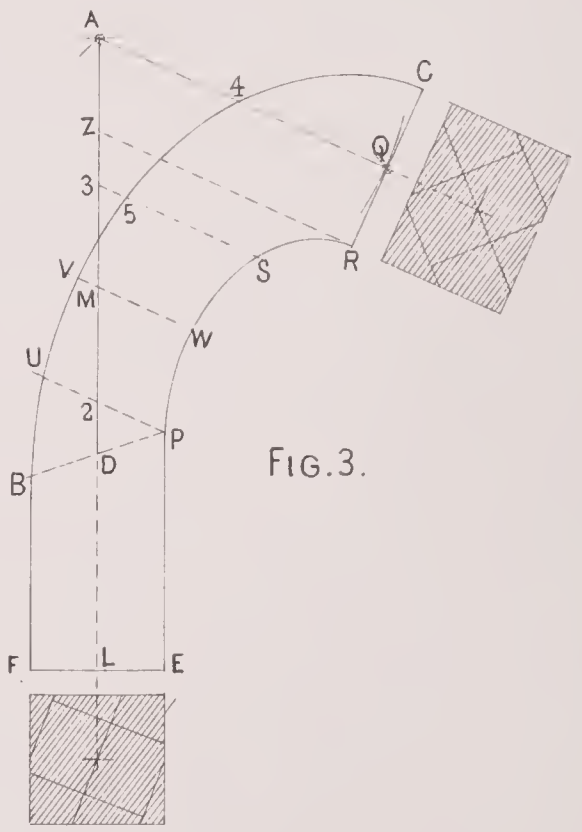


FIG. 3.

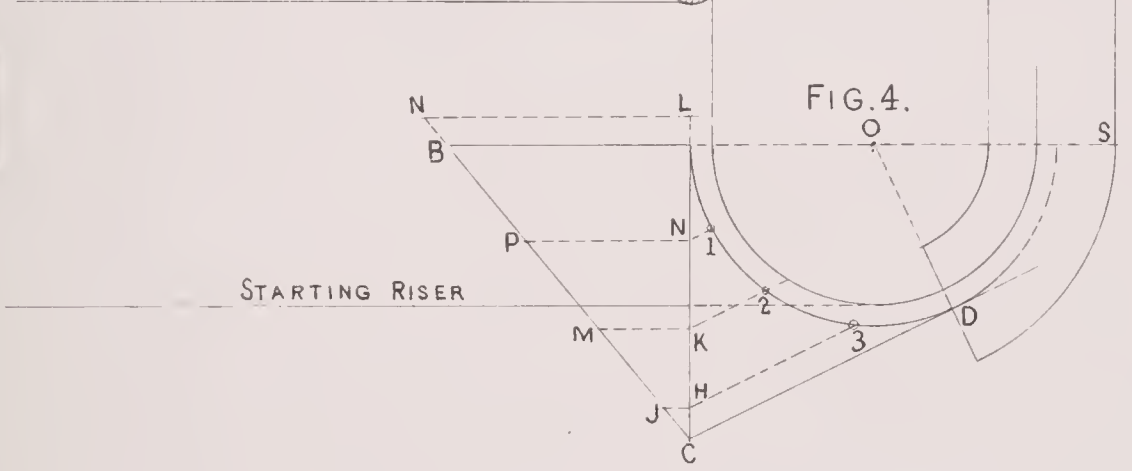


FIG. 4.

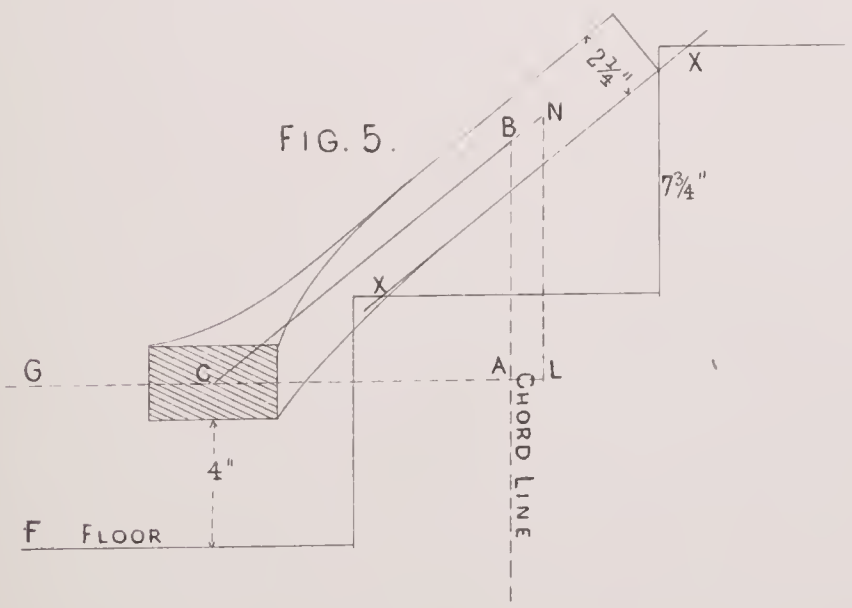


FIG. 5.

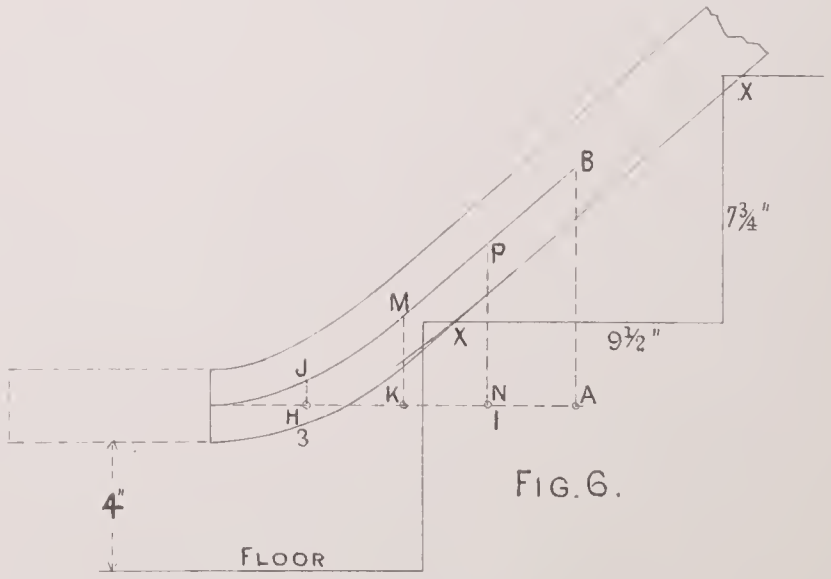


FIG. 6.

SCALE 1½ IN. = 1 FT.

PLATE 34.

Fig. 1. Plan of the Top Portion of a Straight Flight of Stairs with a Seven-inch Cylinder, the Landing Riser set in the Whole Depth of the Cylinder.—This plan is introduced for the purpose of showing how to draw a face-mould and work a wreath, taking the whole cylinder in one piece. Having made the plan as shown and described, proceed to set up an elevation of tread and rises, as at FIG. 2. Let the bottom line of rail rest on X X, the centres of the short balusters, and place the centre line of rail A E in position parallel to X X; the point E is fixed by the level line E G and its height F G from the floor. The point A is fixed by the position of the chord-line as taken from the plan. A B is drawn parallel to the line of the floor. The points A and E being determined together with the height B E, that is all that is required of the elevation.

Fig. 3. Plan of Rail with its Centre Line as given at Fig. 1, to be Prepared for Drawing a Face-mould by which to get out in One Piece a Wreath for the Whole Cylinder; also Showing how to Construct a Paper Representation of a Solid, which Objectively Exhibits the Principles involved in this Case of Face-mould.—Draw A B at right angles to A Q; make A B E equal A B E of FIG. 2. From B draw the line B P, touching the centre line of rail; from D at right angles to B P draw D C; parallel to B O draw Q U, O S, 2, 5, D J Z and H X 7; parallel to B E draw U V, S T, 5, 6, J 1 and X I.

To Find the Angle with which to Square the Wreath at the Joint over A:—From D draw D F at right angles to A D; make D F equal J K; connect F A: then the bevel at F will give the angle sought. The joint of the wreath over Q will require some over-wood and will also have to be cut plumb.

To Find the Angle with which to Cut the Joint of the Wreath over Q Plumb:—On B as centre describe an arc touching the line E A, and at 10 connect 10 A: then the bevel at 10 will give the required angle.

To Find the Amount of Over-wood required in Making the Joint of Wreath over Q Plumb:—Make 22, 24 equal two inches, which is half the thickness of rail plank; draw 22, 24 at right angles to 10, A: then 10, 22 will be the extent of over-wood.

To Find the Angle with which to Square the Wreath at the Plumbed Joint over Q:—At P draw P N at right angles to P A; make P N equal B E; connect N A: then the bevel at N will give the angle sought.

To Find the Slide Distance, or Movement of Face-mould, to Plumb the Sides of the Wreath:—Prolong P B to Y indefinitely; from A draw A W indefinitely and parallel to P B; anywhere above E draw 12, W at right angles to Y B; make 12, Y equal B E; connect Y W; make 11, 4 at right angles to Y W and equal to two inches, half the thickness of plank: then 11, Y is the slide distance.

The Paper Representation of a Solid is bounded on its base by the lines A B P A; the vertical side B P is formed by raising the perpendiculars B 16 and P 15, each to equal B E; connect 16, 15.

To Develop the Cutting Plane:—On 15 as centre with N A as radius describe an arc at 18, and on 16 as centre with A E as radius intersect the arc at 18; connect 15, 18 and 16, 18. Cut through the paper the outlines A E B 16, 18, 15 P N A; then with a sharp-pointed instrument scratch the base-lines A B P A, and the level line 16, 15; touch the cut edges with glue and fold them in place with the faces turned so that all the lines are on the outside.

Fig. 4. Face-mould for the Whole Cylinder from the Plan Fig. 3.—Draw the line G C equal to G C of FIG. 3. On G as centre, with A E of FIG. 3 as radius, describe an arc at E, and on C as centre, with C B of FIG. 3 as radius, intersect the arc at E; connect E C and E G; prolong E G to P indefinitely; make G I J 6 T V equal A I 1 6 T V of FIG. 3; parallel to E C draw V Q, T O, 6, 3, 2, J Z Z and I H 7; make E 8 equal B 8 of FIG. 3; make V U Q equal U R Q of FIG. 3; make T O equal S O of FIG. 3; make 6, 3, 2 equal 5, 3, 2 of FIG. 3; make J Z, J Z equal J Z, J Z of FIG. 3; make I, 7 and I H equal X 7 and X H of FIG. 3; through G Q draw A B; make G B equal G H; parallel to G P draw H F and B Y; draw F Y at right angles to G P; make C R equal O C; make Q A equal Q 2; through A R 8 U Z 7 B of the convex and 2, O 3 Z H of the concave trace the edges of the face-mould. Through C at right angles to C E draw the slide line R P. G P for straight wood equals A P of FIG. 2, but need not be in any case more than two or three inches. In laying out the wreath add to the joint 2 A over-wood equal to 10, 22 of FIG. 3, which is required to plumb the joint as shown at FIG. 6.

Fig. 5. Squaring the Wreath.—The angle for squaring the wreath at the lower joint F is taken by the bevel F at FIG. 3. The face mould is moved along the slide-line 11, K from 11 to Y, equal to 11, Y of FIG. 3. The position is shown by the dotted lines. The upper or level joint has to be cut plumb along the line 2 A in the direction Q B, as shown at FIG. 6, by the use of the bevel 10 of FIG. 3. Q G B equals 10 Z W of FIG. 6. The sliding of the face-mould will give the plumb-joint if wood enough is left on. After cutting the joint plumb it is laid out for squaring by the bevel N, taken from N of FIG. 3, the plumb-line N C passing through the centre G; but as the plane of the plank brings the centre G too low by the distance M L of FIG. 3, the centre G has to be raised that much, to H, and if the wood proves scant on the top for the form of rail, glue on the piece cut off at the bottom.

Finally, the case here presented is left to the decision of intelligent mechanics as to its economy and value in practice. My own opinion is that for small-sized moulded rails and cylinders not over eight inches, with proper management and use of the band-saw, it will effect a considerable saving. For instance, after the level joint is made plumb by the use of the bevel 10, or by sliding the face-mould as directed, and the squaring lines are marked on both joints, with the band-saw cut off the level slab J X X; rest J X X on the saw-table, and the wreath will be in position to cut the sides plumb. If desirable a slab may also be sawed off the lower end along the line Z Z and on the angle Z Z, as shown at FIG. 2. When the sides of the wreath are sawed plumb, lay the convex side on the saw-table and saw the top and bottom, rolling the wreath on the table as required; cut with care, and at first a little at a time. Practice will soon make it easy to cut the wreath comparatively perfect, ready to bolt to the adjoining straight, with little cutting and shaping to do by hand. *A good way to test this case would be to get it out of soft wood as a trial, either half or full size, as convenient.*

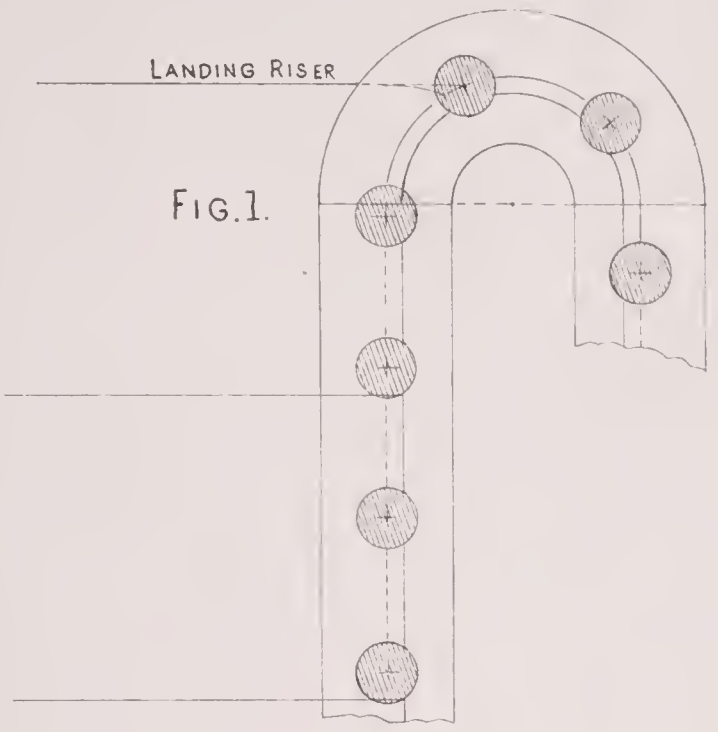


FIG. 1.

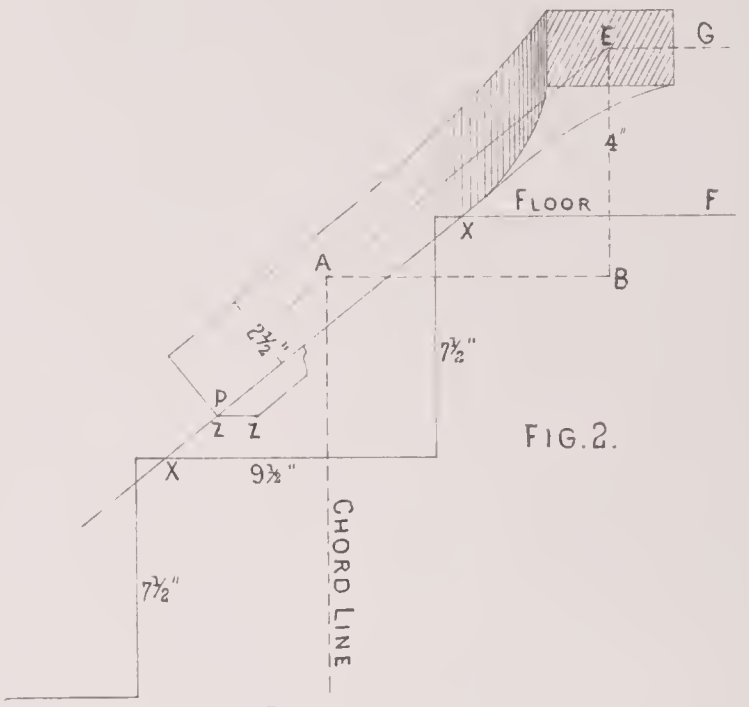


FIG. 2.

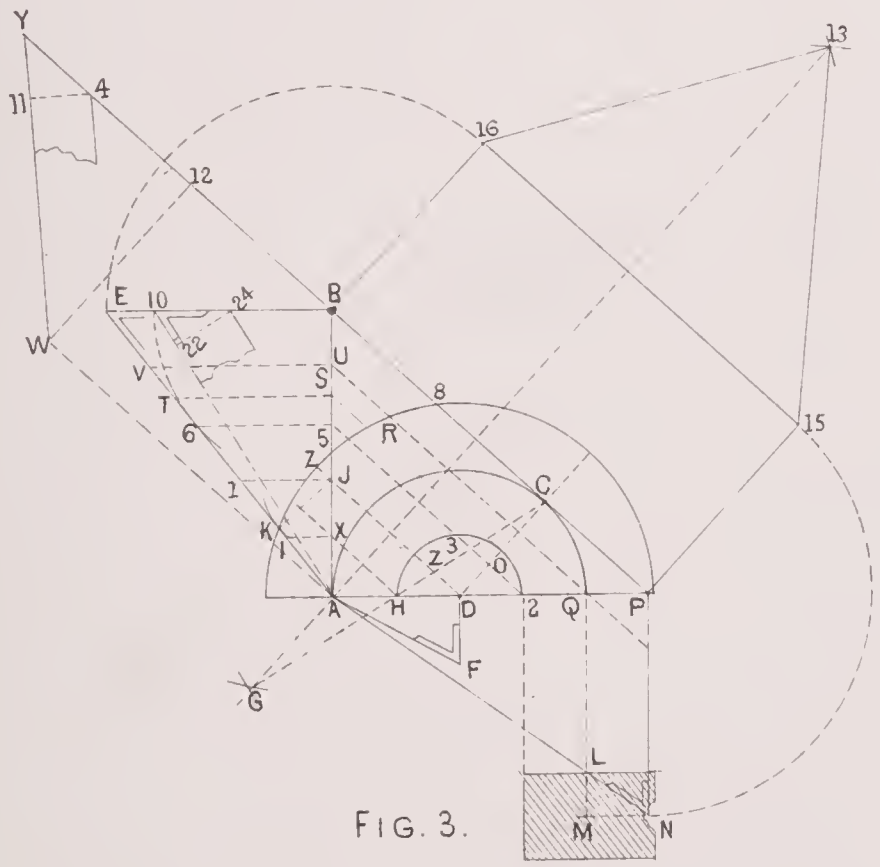


FIG. 3.

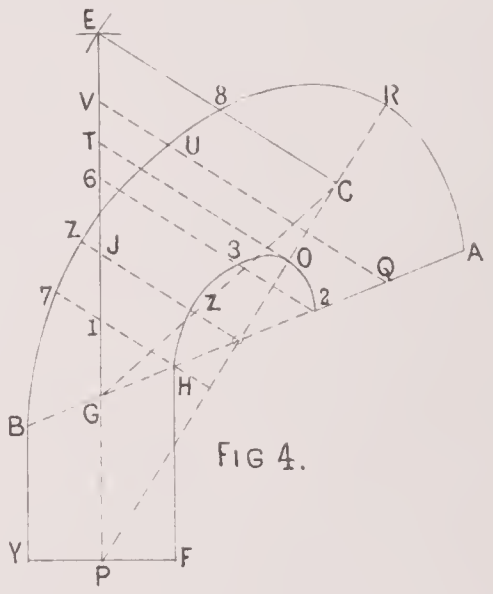


FIG 4.

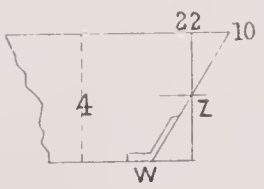


FIG. 6.

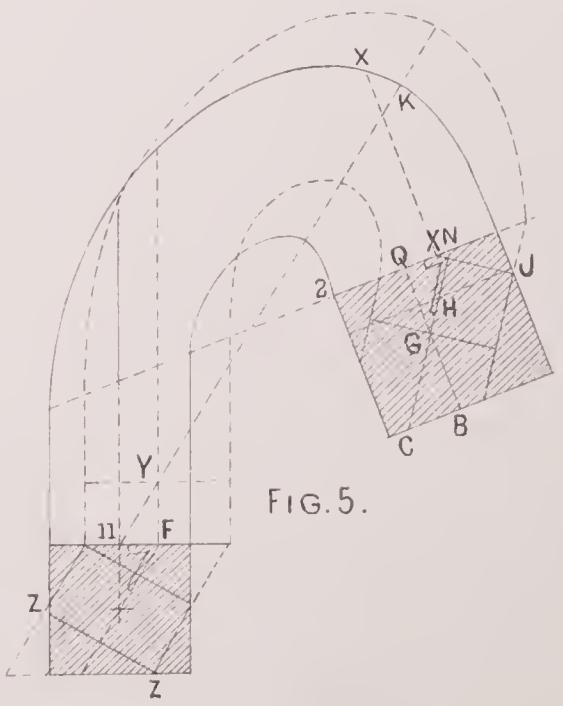


FIG. 5.

SCALE 1½ IN. = 1 FT.

PLATE 35.

Fig. 1. Plan of the Top Portion of a Straight Flight of Stairs with a Seven-inch Cylinder, the Landing Riser set at the Chord-line or Commencement of the Cylinder.—A second way of drawing a face-mould and working a wreath for the cylinder in one piece. This method, as compared with that given at PLATE 34, will at least have the merit of greater simplicity. After drawing the plan as shown and described, set up the tread and rise as at FIG. 2. Rest the bottom of the rail at X X, the centres of the short balusters. The bottom of the level rail B is set up four inches as usual. Draw D B parallel to the floor-line; let B H equal the thickness of rail; make H K parallel to B D; at E draw E F indefinitely and at right angles to X X; at G draw G K parallel to the riser. At right angles to A B of FIG. 1 draw B 2, O H, S Y, E X, P G and A Z, all indefinitely; draw H K of FIG. 2 to Y of FIG. 1; parallel to Y K draw D of FIG. 2. At FIG. 1 make F Z the thickness of rail and draw Z X parallel to F D; touching the angles D and C draw the line 4, 6; parallel to D C and touching the angles Y and Z draw L 2; at right angles to L 2 draw lines touching W, N, X and F; then these square sections show the plank canted in position, with the joints and the wreath as it is to be first sawed out. Make 2 J equal C D of FIG. 1; parallel to L 2 draw J 5; at right angles to L 2 draw 2 J, H M, G 8, Z 5, etc., measuring all the points for tracing the edges of the face-mould from the line A B, and setting them off from the line J 5; as I M equals O Q, K 8 equals P R, etc.

To Find the Angle for the Joint E G of the Wreath, Fig. 2, to be Applied from the Face of the Plank along the Line 4 U of Fig. 1:—From V of FIG. 1 draw a line to K of FIG. 2, parallel to N D; from U of FIG. 1 draw a line to J of FIG. 2, parallel to V K; at FIG. 2, parallel to the rise-line, draw J K; make V T of FIG. 1 equal F K of FIG. 2; connect T U; then the bevel at U will give the angle required. The application of the bevel U for the joint along 4 U is shown at FIG. 3. In marking out the wreath it would be better to leave a half-inch more wood at the concave,—in fact, a little more wood, both thickness and width, would be well, for this wreath is forced at the lower joint, and although its shape would be passable, it could be much improved with more wood. After preparing the lower joint with the bevel U, and facing the upper joint on the line Y 2, square from the face of the plank. Lay out the squaring of the upper joint with the bevel H as seen; then sliding the face-mould will give the plumb sides at the lower end. Cut off the slab W Y at right angles to the joint, and resting the cut portion on the saw-table,* with a suitable block tacked temporarily to the under side of the end thrown up to keep it in position, saw the two sides plumb; then rolling the wreath on the convex side, saw the top and bottom to the required shape. Some of the slab cut off at the bottom may have to be glued on at the top, depending on the shape and thickness of the rail.

WAINSCOT.

Fig. 4. Vertical Cross-section of Hall Wainscot, of which an Elevation of a Portion is made at Fig. 5, as it Appears along the Wall, in Connection with the Level Wainscot at the Starting of a Staircase.—In the best panel-work of hard wood, the frame is put together, the mouldings glued in place, and the whole finished and varnished. Afterwards the varnished panels are set in from the back and fastened at X X with three-cornered pieces of stout sheet-metal driven in the frame; or in place of the metal strips of wood are nailed into the frame and against the panels at X X. As to the height, wainscot should be up the flight as compared with the height of the connecting level wainscot. There is no fixed rule; but as a basis, let A B of FIG. 5, the level wainscot, be three feet in height as at FIG. 4. Make a vertical line along any riser of the flight C D equal three feet; then if, after measuring on the line H J—which is drawn at right angles to the inclined string—the width of bottom rail E, middle rail F, and top rail G, as given at the section, FIG. 4, the space left for panels is unpleasantly narrow, changes may be made and the height given at C D altered to suit.

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* The wreath may be placed in the position here referred to (after the sides have been sawed plumb and before the top is shaped), and the joint as at FIG. 3 tested by the pitch-board.

FIG. 3.

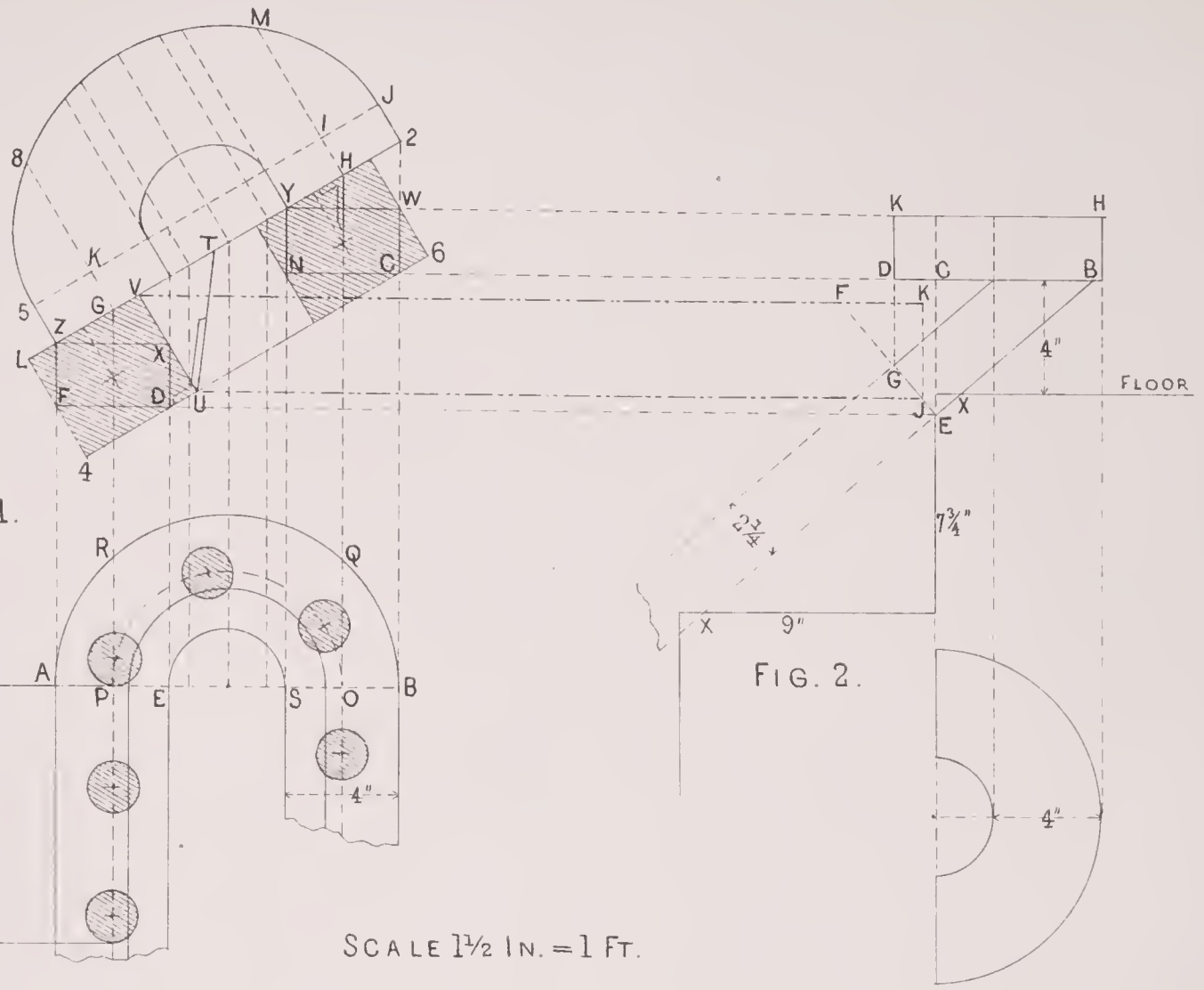

FIG. 1.

FIG. 2.

SCALE 1½ IN. = 1 FT.

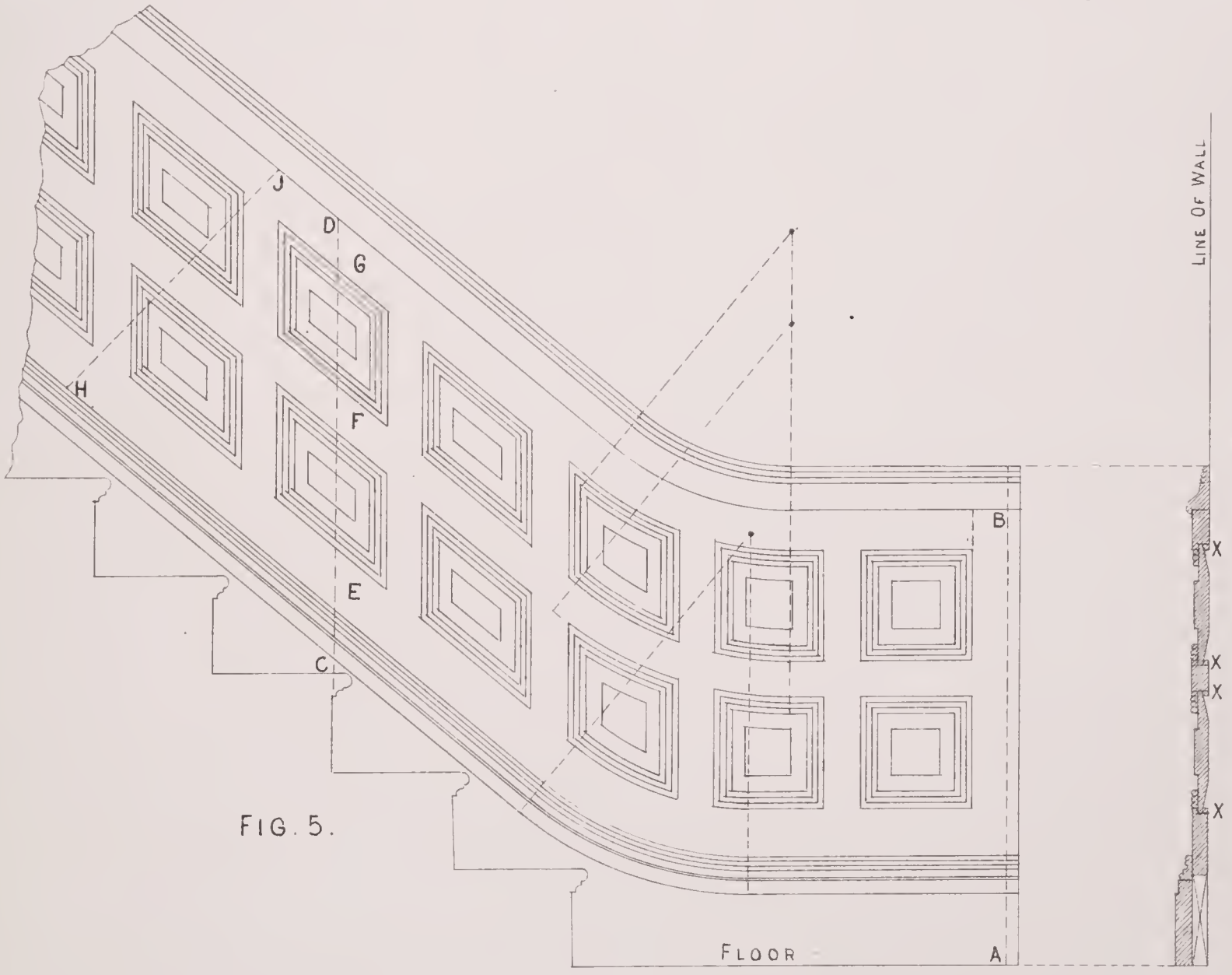

FIG. 5.

FIG. 4.

SCALE ¾ IN. = 1 FT.

PLATE 36.

Fig. 1. Plan of a Winding Stairs Turning One Quarter at or about the Middle of the Flight.—This plan is given at PLATE No. 5, FIG. 11. After making the plan, describe the centre line of the rail Q H, the plan tangents Q C and C H. Place the centres of balusters as required. Before the plan can be completely prepared to draw a parallel pattern or a face-mould, the elevation must be drawn.

Fig. 2. Elevation of Plan as given at Fig. 1.—Set up the treads and rises as figured and given at the plan according to the scale. The treads in the cylinder must be measured on the centre line of the rail, and each tread taken in two parts for the purpose of getting more accurately the stretch-out of the centre line. Place the centres of balusters on each tread as shown on the plan, and except at the centres of the short balusters O, draw lines parallel to the rise-lines, and indefinitely. At the upper portion of the elevation through the centres of the short balusters O O draw the bottom line of the rail, and place the centre line N C in position parallel to O O, but indefinite in length. Anywhere along the upper chord-line set off the length of plan tangent H C of FIG. 1, and draw the line C M parallel to the chord-line; and where the centre line N A intersects at C, draw the line C D at right angles to the chord-line. Anywhere along the lower chord-line P B set off the length of the plan tangent Q C of FIG. 1 and draw the line F E. E is a fixed point from which the line E L may be drawn to suit its position over the winders and the requirements of the ramp. Wherever the line E L intersects the chord-line P B as at B, draw the line B F at right angles to the chord-line. Make A J equal four inches for straight wood on the upper end of the wreath-piece; and make B G also four inches for straight wood on the lower end. The ramp is curved as shown. Again at FIG. 1 make C E at right angles to Q C and equal to F E of FIG. 2; connect E Q; make H D at right angles to C H and equal to D A of FIG. 2; connect D C.

To Find the Directing Level Line:—Make C G equal H D; make G F parallel to C Q, and F O parallel to C E; connect O N, which is the level line sought. Parallel to N O draw I Z, U O, 2 T, C M and 3 W; parallel to C E draw T X and Z Y; parallel to H D draw W K; from H at right angles to N O draw H A indefinitely; from Q at right angles to N O draw Q B indefinitely; on C as centre with C D as radius describe the arc D A; again on C as centre with E Q as radius describe an arc at B; connect B A.

To Find the Angle with which to Square the Wreath-piece at its Joint over H:—Make H L equal H J; connect L M; then the bevel at L will give the angle required.

To Find the Angle with which to Square the Wreath-piece at its Joint over Q:—Prolong H N to R indefinitely; make N R equal O P; connect R Q; then the bevel at R will give the angle sought.

To Develop the Centre Line of the Wreath-piece in Position over the Elevation, Fig. 2.—Make Z Y, T X and W K equal the heights at the corresponding letters of FIG. 1; then through B Y H K A trace the centre line of the wreath. Set off half the thickness of rail each side of the centre as shown by the dotted lines.

To Find the Length of Balusters:—Take for example the one marked 3; 3 V measures $5\frac{1}{4}''$, which, added to $2'.2''$, the length of short baluster at O, equals $2'.7\frac{1}{4}''$ between the top of the step 3 and the bottom of the rail V at the centre of the baluster.

Fig. 3. Parallel Pattern for the Wreath-piece over the Plan, Fig. 1.—Make the line B D equal B A of FIG. 1; make D S equal A S of FIG. 1; on D as centre with C D of FIG. 1 as radius describe an arc at C; and on B as centre with Q E of FIG. 1 as radius intersect the arc at C; also on S as centre with S C of FIG. 1 as radius test the intersection of the arcs at C; connect D C, C B and S C; prolong C B to G and C D to J; make B G equal B G of FIG. 2; make D J equal A J of FIG. 2; make B Y F X equal Q Y F X of FIG. 1; make C K equal C K of FIG. 1; parallel to the level line C S draw K 3, X 2, F U and Y I; make Y I, F U, X 2 and C V equal Z I, O U, T 2 and C V of FIG. 1; make K 3 equal W 3 of FIG. 1. The joints J and G are made at right angles to the tangents.

At a trial—laying out the squaring of the wreath-piece at joint J with the bevel L of FIG. 1, also joint G with bevel R of FIG. 1—it is found that the position of the form of rail at joint J takes the greatest width of stuff, equal to $5''$, therefore, with $2\frac{1}{2}''$ radius describe circles on the centres G B 1 U 2 V 3 D J, and trace lines touching the circles to complete the pattern.

Development of the centre line of wreath-piece in cases of this kind is given in detail at PLATE No. 20 by the quarter-circle Q V of FIG. 3. Face-mould and parallel pattern of this character is treated in detail at PLATE No. 12.

FIG. 1

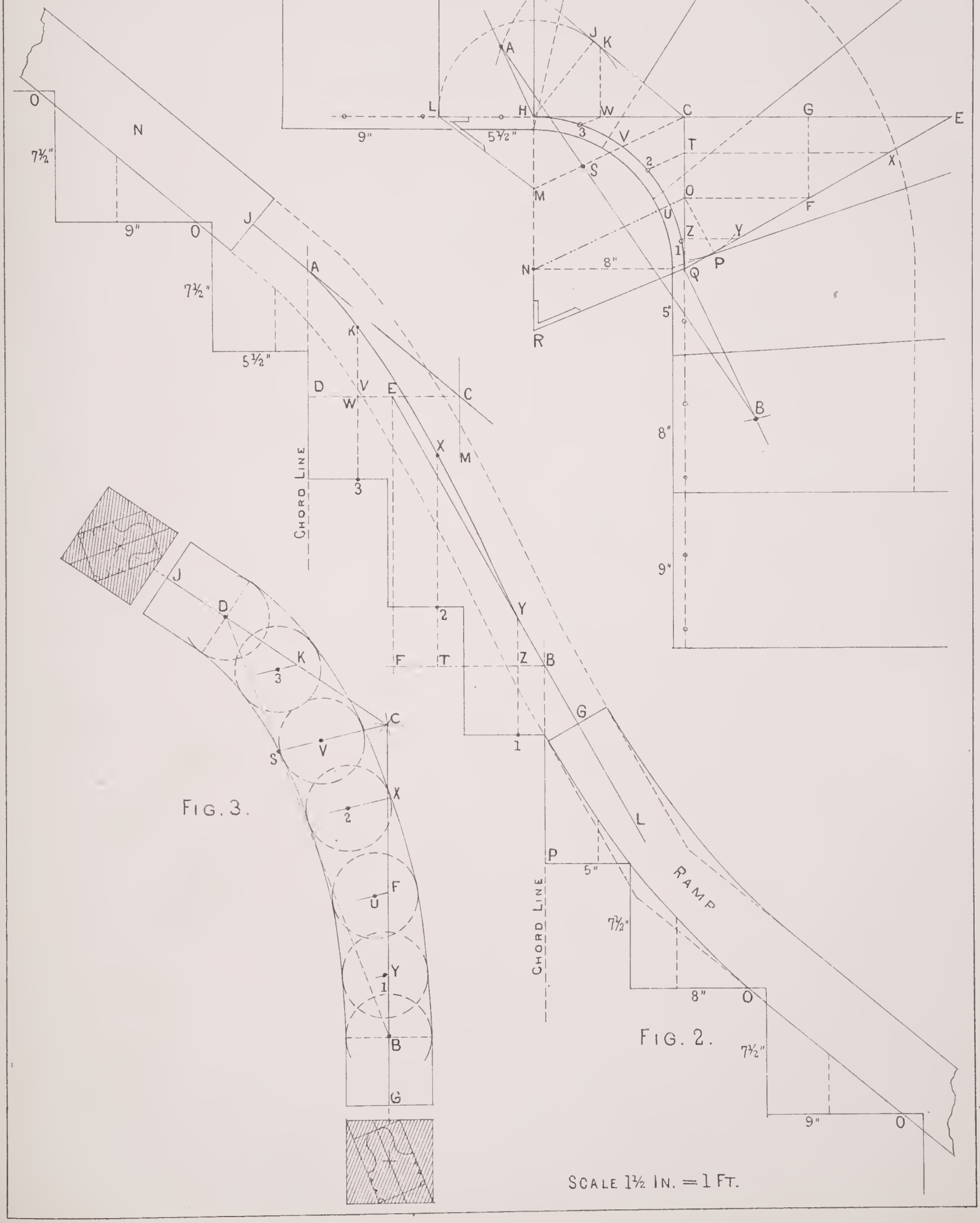

FIG. 3.

FIG. 2.

SCALE 1½ IN. = 1 FT.

PLATE 37.

Fig. 1. Plan of a Half-turn Platform Stairs with the Opening between the Strings—Usually Built to Connect in the Form of a Semicircle—Composed of Two Quarter-circles with Straight between.—Plans of platform stairs differently treated are given at PLATES 6 and 7. The situation of the risers in connection with the chord lines is, in this case, determined by trial through the elevations of tread and rise set up at FIGS. 2 and 3.

Fig. 2.—Let the bottom line of hand-rail pass through X X, the centres of short balusters; the thickness of rail is set off parallel to X X by the line E D; the line C B is the centre of a four-inch plank, from which the wreath-piece is to be worked out. A J is four inches, which the rail is to rise above the floor more than the height to be raised at X X; J B is half the thickness of rail, and the height of B, touching the centre line C B, determines the exact position of B to the riser H; and at the plan FIG. 1 A H is made to equal A H of FIG. 2. *This explanation and the corresponding letters will serve* FIG. 3. At FIG. 1, to prepare for drawing the face-mould, place the pitch-board as shown, marking the line of hypothenuse W M; prolong U A to M; parallel to U M draw T N and V O.

Fig. 4. Face-mould from Plan Fig. 1; also the Squaring of Wreath-piece at Both Joints.—Draw U A and A K at right angles; make A I L U equal A I L U of FIG. 1; make A N O W equal M N O W of FIG. 1; make W K four inches for straight wood; through N, O, W, K, parallel to U A, draw Y Z, 1 V, F E and B C; make W F and W E each equal the same at FIG 1; make O 1 and O V equal P 1 and P V of FIG. 1; make N Y equal S Y of FIG. 1; parallel to W K draw F B and E C; make L J equal L T; parallel to L U draw J R; through U draw R Z parallel to A W; through F 1 Y I J of the convex and E V T of the concave trace the edges of the face-mould. The squaring of the centre joint U by the use of the pitch-board, as shown, is a sufficient explanation. At joint K the sides of the rail are at right angles to the plane of the plank; D H S S is the over-wood to be cut away at the bottom of the lower wreath-piece, and at the top of the upper one.

Fig. 5. Plan, as given at Plate 5, Fig. 10, of a Quarter-platform Stairs turning One Quarter with a Quarter-cylinder.—Draw the plan of rail, also the centre line, and upon the latter space the balusters, as required. Make the tangents to the centre line of the rail, B F and B O, and let the distance from the angle B, both ways to each riser, equal half a tread—$4\frac{1}{2}''$ from B to S and $4\frac{1}{2}''$ from B to 1. By this arrangement there is between the two risers one tread, which brings the wreath-piece on a common inclination with the flight, and makes the best possible shape of it. To further prepare the plan for drawing the face-mould, place the tread of the pitch-board on the tangent B O and mark the line B Q; prolong the tangent O B to C; prolong A O to Q. A line connecting A B will be the level line. Parallel to A B draw R L and H G; parallel to O Q draw X N and 1 M; parallel to B C draw G E; from F through O draw F P; on B as centre with B Q for radius describe the arc Q P.

To Find the Angle with which to Square Both Joints of the Wreath-piece:—On B as centre describe an arc touching the line C F and D; connect D F: then the bevel at D will give the angle required.

Fig. 6. Elevation of Tread and Rise, including the Platform, as given at Plan and as Figured.—The platform is measured at the plan on the centre line in two parts from riser to riser. The heights and inclinations, the rail above and below, the joints Y and Y, are all shown in position; also the development of the centre line of wreath. The letters correspond with the plan FIG. 5 and with those at the joints of the face-mould. The length of baluster is here determined as before explained.

Fig 7. Face-mould over Plan Fig. 5; also Showing the Squaring of the Wreath-piece at the Joints.—Draw the line P F indefinitely; make K P and K F each equal K P of FIG. 5; from K at right angles to F P draw K C; make K C equal K B of FIG. 5; connect C P and C F; prolong C F and C P to Y; make P Y and F Y equal the same at FIG. 6; make the joints Y, Y at right angles to the tangents; make F M and P M each equal Q M of FIG. 5; through M and M parallel to C K draw L R, L R; make M L and M R equal 1 L and 1 R of FIG. 5; make C Z equal B Z of FIG. 5; through F and through P draw R V; make F V equal F R, and P V equal P R; parallel to C Y draw V X and R X at each end; through V L Z L V of the convex and R K R of the concave trace the edges of the face-mould. The angle for squaring the wreath-piece at both joints is given by the bevel D, FIG. 5. The face-mould, FIG. 7, is treated in detail at PLATE No. 11, and face mould, FIG. 4, is also treated in detail at PLATE No. 10.

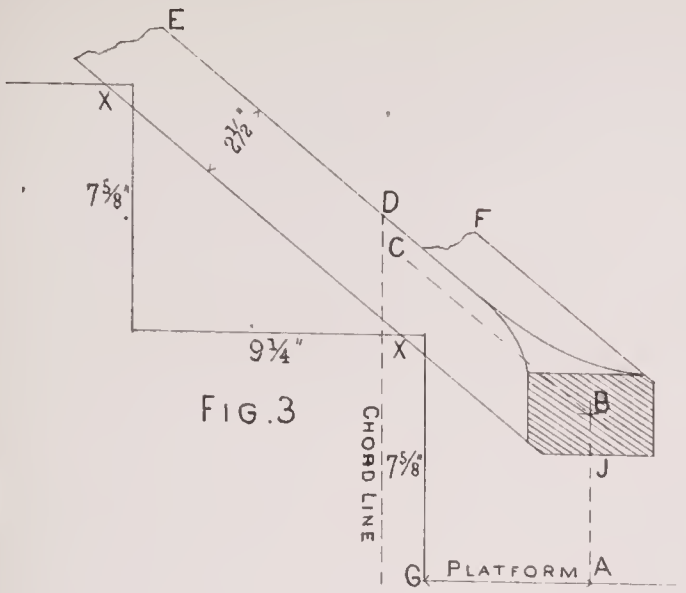

FIG. 3

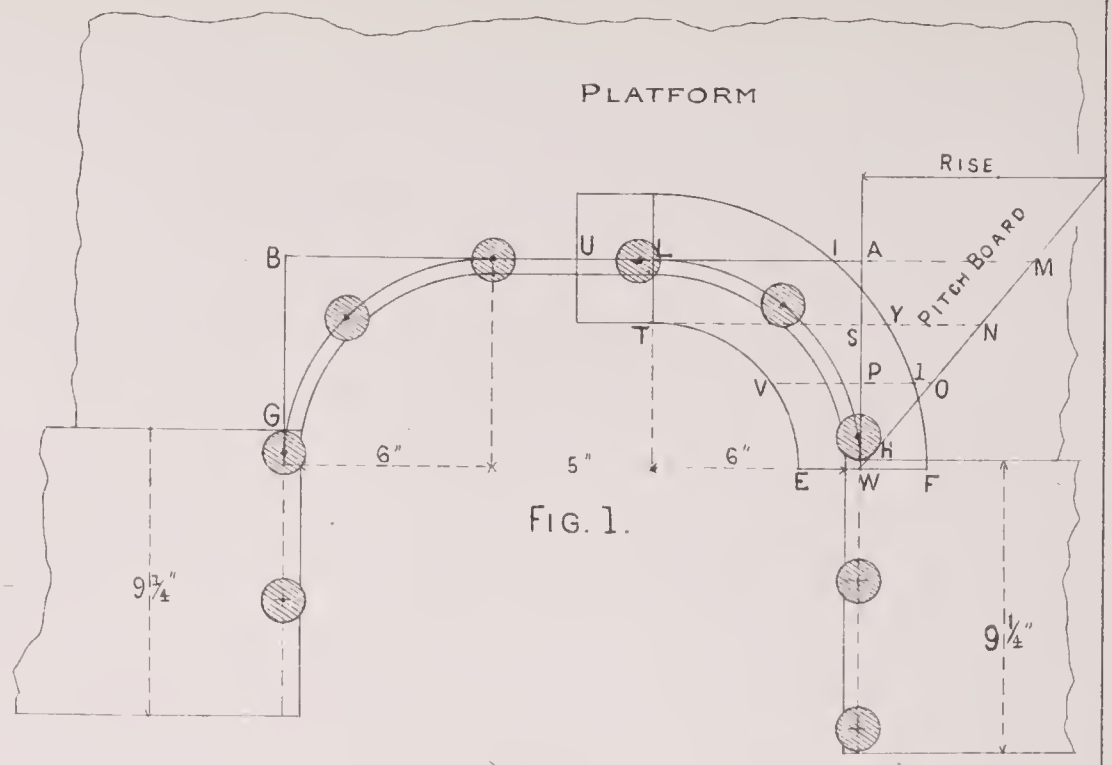

FIG. 1.

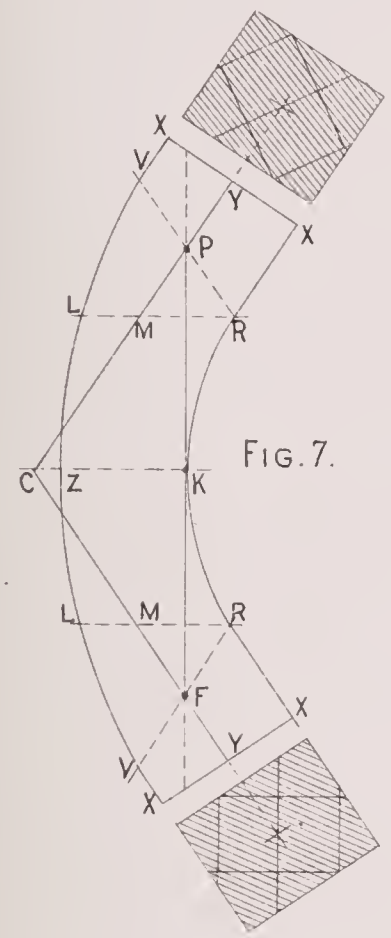

FIG. 7.

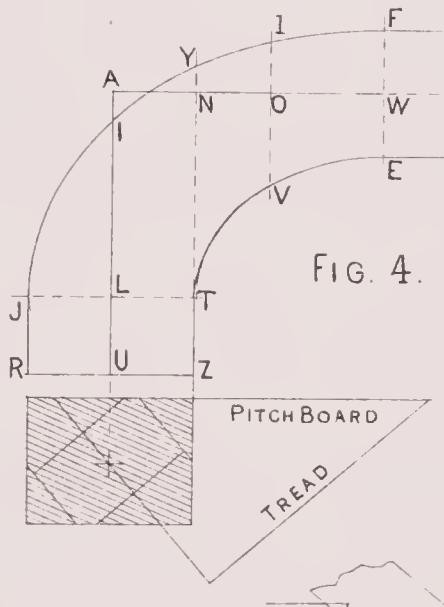

FIG. 4.

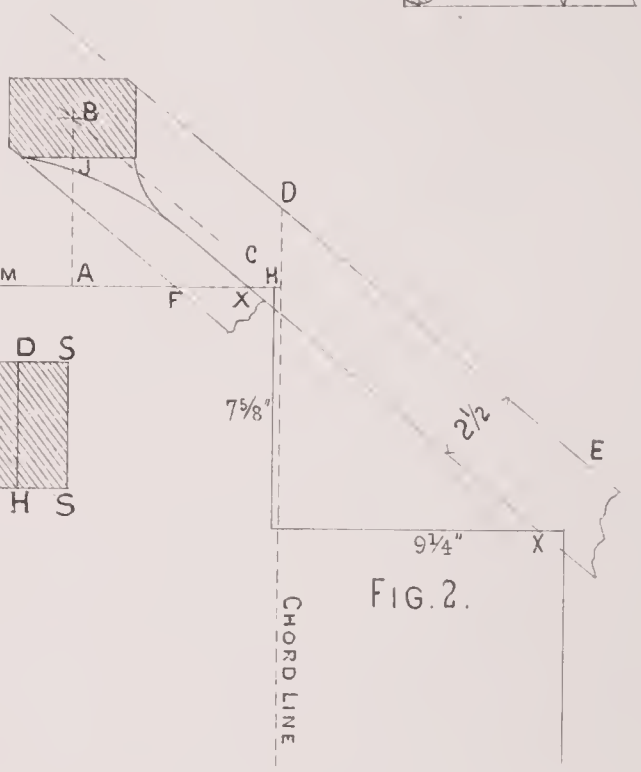

FIG. 2.

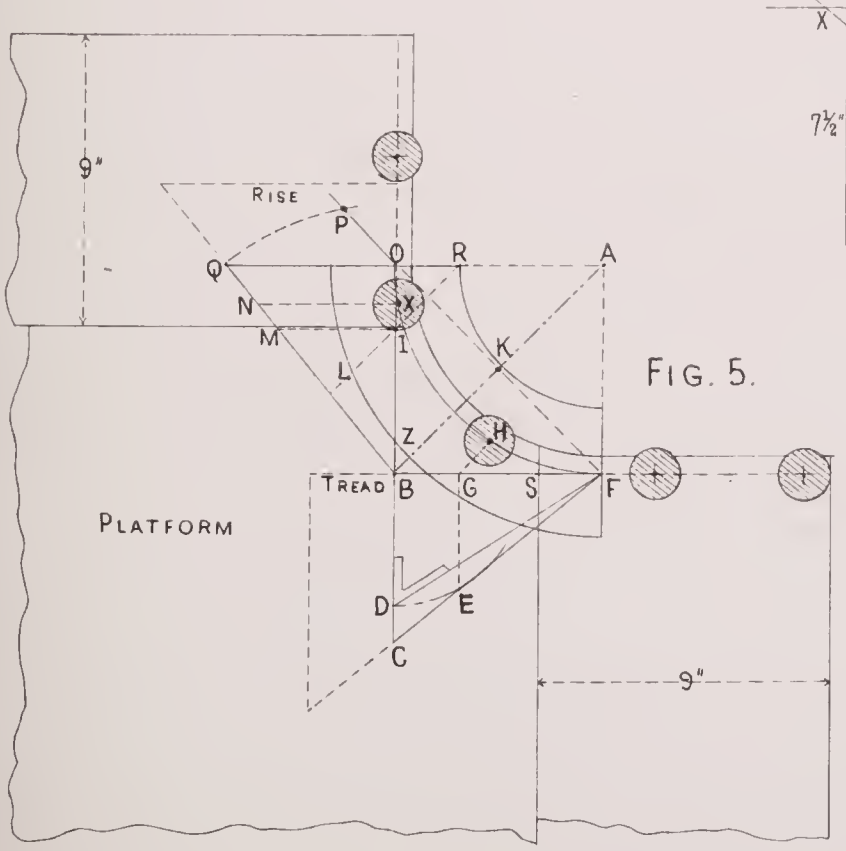

FIG. 5.

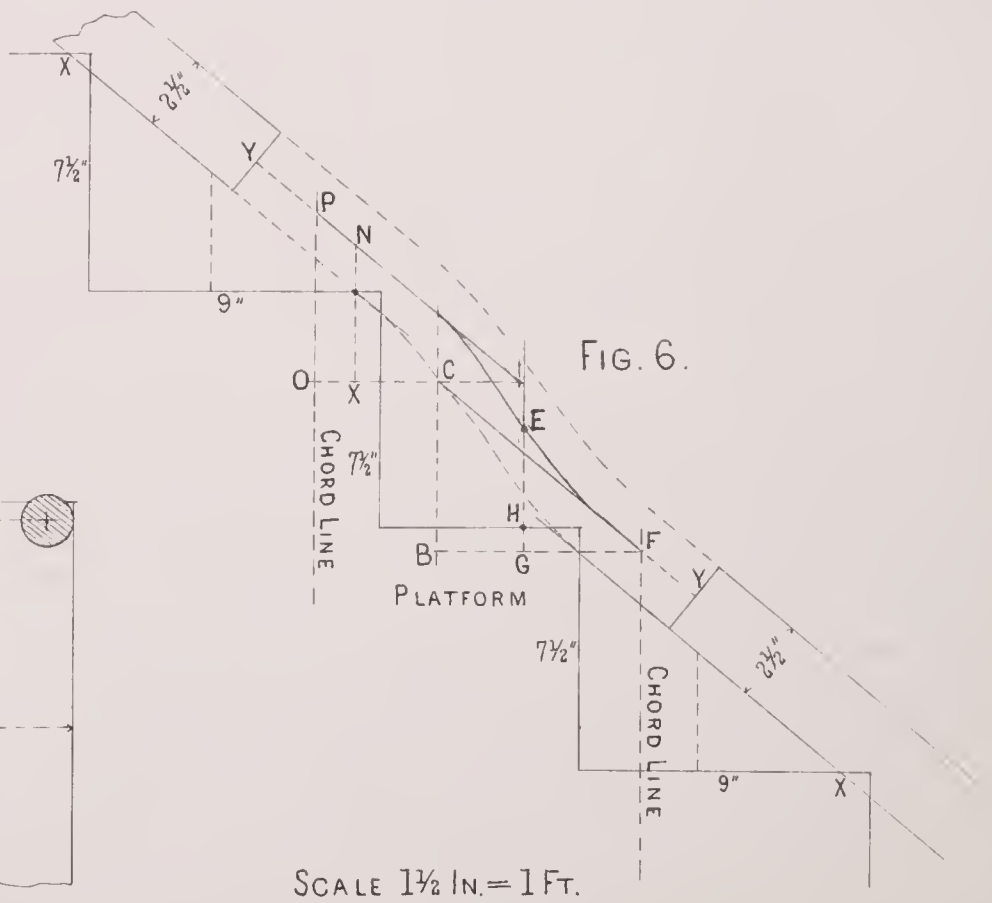

FIG. 6.

SCALE 1½ IN. = 1 FT.

PLATE 38.

Fig. 1. Plan of a Platform Stairs with the Risers at Platform set in the Whole Depth of the Cylinder.—Draw the centre line of rail and space the balusters as required; also draw O A and A Q, F G and G C tangents to the centre line of rail at each quarter-circle. To prepare the plan for measurements that will develop the centre line of wreath, or to draw the face-mould, the elevation must first be set up.

Fig. 2. Elevation of Treads and Rises as given at the Plan and as Figured; also Development of the Centre Line of Wreath.—Let the bottom line of rail above and below the platform pass through X X, the centres of short balusters. Place the chord-lines—of which there are four—as given on the plan. Draw the centre line of rail L B and G R parallel to X X; at right angles to the chord-line D O draw O A equal to the first tangent O A of FIG. 1. Parallel to D O draw A B; at right angles to A B, touching B, draw Q T; make Q T equal the second tangent A Q of FIG. 1; make C G at right angles to C M and equal to the tangent C G of FIG. 1; and draw the line E Z parallel to J F; from Z draw the line Z T; where the inclined line Z T intersects the chord-line J F at F, draw F E at right angles to J F. Place the balusters numbered 1, 2, 3, 4, 5, 6 as on the plan, and draw a line through the place of each baluster parallel to the rise-line and indefinitely.

To Prepare the Plan, Fig. 1, for Finding the Lengths of Balusters:—Make C M G equal the same of FIG. 2; make G Z F equal E Z F of FIG. 2; make Q N A equal Q N T of FIG. 2; make A B O equal the same at FIG. 2; make A J equal Q N; make J Y parallel to A O, and Y 8 parallel to B A; connect 8 R; parallel to 8 R draw 2 V; parallel to Q N draw V W; make M H equal G Z; draw H E parallel to C G, and E T parallel to C M; connect T S; parallel to S T draw 5 K and 4, 1; parallel to C M draw K U; parallel to G Z draw I P. The heights for the balusters are taken as numbered and lettered, and set up at the elevation, FIG. 2, as designated by the same numbers and letters; then through these letters—M U P F N W Y O—trace the centre line of the wreath-pieces. Set off each side of the centre half the thickness of rail as shown by the dotted lines; next, *to get the length of balusters:* take for example baluster 4—this measures from the platform to the bottom of the rail, $4\frac{3}{4}''$, which, added to $2'.2''$—the length of short balusters at X X—equals $2'.6\frac{3}{4}''$ from the top of the platform to the bottom of the wreath along the centre line of baluster.

Fig. 3. Plan of the Lower Quarter Wreath-piece.—The heights A B and Q N are taken from those lettered the same at FIG. 2. Make A F equal Q N; draw F E parallel to A O, and E D parallel to B A; connect C D, which is the directing level line; parallel to C D draw V W, A K, R S and Q Y; at right angles to the level line C D from O and Q draw O M; also Q P, each indefinitely. On A as centre with B O as radius describe an arc at M; again on A as centre with A N as radius describe the arc N P, connect P M.

To Find the Angle with which to Square the Wreath-piece at the Joint over O:—Prolong Q C to H; make C H equal D I; connect H O; then the bevel at H will give the angle required.

To Find the Angle with which to Square the Wreath-piece at the Joint over Q:—Prolong A Q to L; make Q L equal Q 8; connect L K; then the bevel at L contains the angle sought.

Fig. 4. Face-mould taken from Plan of Quarter-circle Fig. 3, also Showing the Squaring of the Wreath-piece at Both Joints.—Make O N J equal M J P of FIG. 3. On N as centre with N A as radius describe an arc at B; on O as centre with O B of FIG. 3 as radius describe an intersecting arc at B; on J as centre test the intersection at B with J A of FIG. 3 as radius;* connect N B, O B and J B; prolong O L equal to O L of FIG. 2; and prolong B N equal to N S of FIG. 2. Make N T equal N T of FIG. 3; make O X E equal O X E of FIG. 3; parallel to the level line J B draw N Y, T R, E G U and X V; make N Y equal Q Y of FIG. 3; make T R and B 7 Z equal S R and A 7 Z of FIG. 3; make E G, E U equal D G, D U of FIG. 3; make X V equal W V of FIG. 3; through N draw R F; make N F equal N R; make the joints S and L at right angles to the tangents; from R and F draw lines to the joint parallel to N S; through O draw V D; make O D equal O V; through F Y 7 G D of the convex and R Z U V of the concave trace the curved edges of the face-mould. The slide-line is made at right angles to the level line J B. The angle for squaring the wreath-piece at joint L is taken by the bevel at H of FIG 3, and that for the centre joint S is taken by the bevel at L of FIG. 3. This face-mould is treated in detail at PLATE No. 12. The development of the centre line of wreath-piece in a case of this kind is shown in detail at PLATE No. 20, plan of quarter-circle R Q V, and FIG. 4, Q to Y.

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* Instead of using the length of the level line **J A** of FIG. 3, as at **J B** of FIG. 4, as a test, it may be used in any case, together with the length of either one of the tangents, to establish the angle of tangents as at **B**.

PLATFORM

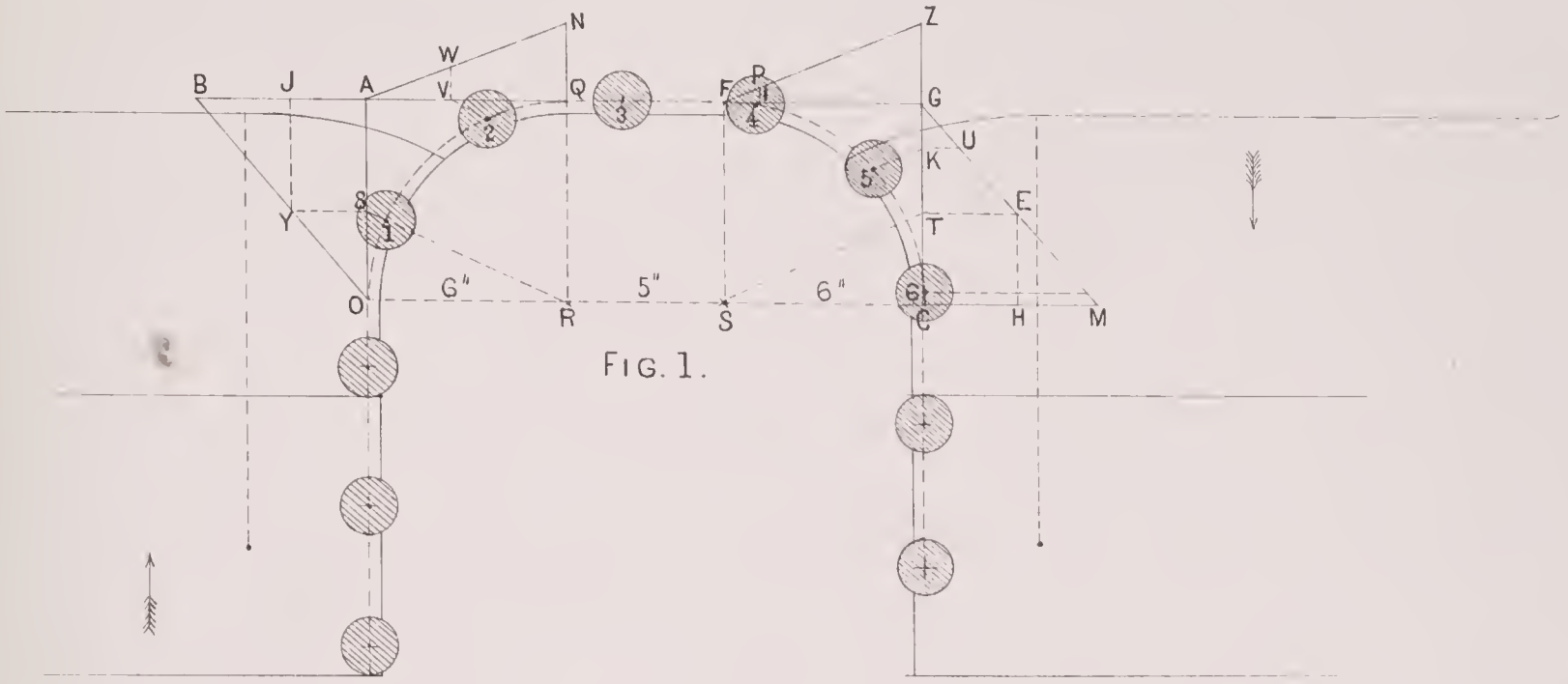

FIG. 1.

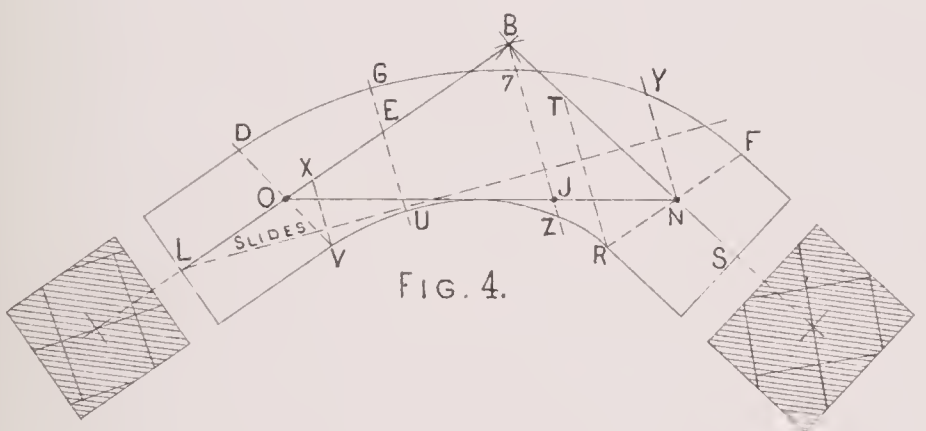

FIG. 4.

FIG. 2.

FIG. 3.

SCALE 1½ IN. = 1 FT.

PLATE 39.

Fig. 1. Plan of Stairs with Two Connecting Platforms Divided by a Riser, set in the Centre of the Cylinder in a Direction Parallel to the Strings; also with the Risers Landing on and Starting from the Platforms, Each set into the Cylinder Three Inches.*—Set off the centre line of rail and space the balusters as required; also draw the tangents D C, C 1 and A F, F H to the centre line of the rail at each quarter-circle; then to find the angles of inclination for the tangents it is necessary first to set up the elevation.

Fig. 2. Elevation of Treads and Risers as given at the Plan and as Figured; also the Development of the Centre Line of Wreath-pieces.—Let the bottom lines of rail above and below the platforms pass through X X, the centres of short balusters. Place the chord-lines, of which there are four, as given on the plan; draw the centre line of rail R E and T G parallel to X X; at right angles to the first chord-line W D draw D C equal to the first tangent D C of Fig. 1; parallel to W D draw C E; touching E, at right angles to 2 B, draw M Q equal to the second tangent 2 C of Fig. 1: then Q becomes a fixed point. At the uppermost chord draw H G at the intersection of the centre line G T, equal to the fourth tangent H F of Fig. 1; from the third chord-line, Y A, make A F equal F A of Fig. 1; make F N parallel to Y A: then N becomes the next higher fixed point. Connect the two fixed points N and Q; where the inclined line N Q intersects the chord-line at A draw A F at right angles to Y A; divide the straight between the two quarters B A in two equal parts at S: then S will be at the centre joint of wreath-pieces. Place the balusters numbered 1, 2, 3, 4, 5 as on the plan, and draw a line through the place of each baluster parallel to the rise-lines indefinitely.

To Prepare the Plan Fig. 1 for Finding the Length of Balusters:—As the angles of inclination in this case happen to be all alike, the angle D E C of Fig. 2 may be set in place over each tangent, as D E C, C B 2, A N F and H J F; connect Q F, also G C. From the centre of baluster 5 draw 5 M parallel to H J; from the centre of baluster 4 draw 4 K parallel to Q F; parallel to F N draw K L; parallel to G C from the centre of baluster 1 draw 1, O; parallel to C E draw O P; at Fig. 2 make O P equal O P of Fig. 1; make K L and U V of Fig. 2 equal K L and 5 M of Fig. 1; then through D P B, A L V J of Fig. 2 trace the centre line of wreath-pieces; set off each side of the centre line half the thickness of rail as shown by the dotted lines.

To Find the Lengths of Balusters:—Take for example No. 2 baluster, where 2 Z equals $4\frac{1}{2}''$, which added to $2'.2''$, the length of short balusters at X X, makes the length of that baluster on the line of its centre from the top of step to the bottom of rail $2'.6\frac{1}{2}''$.

Fig. 3. Plan of the Lower Quarter-circle with Tangents and Angles of Inclination Lettered Alike and as taken from Fig. 1.—From K draw K M parallel to G C; from L draw L H parallel to 2 B; through D and 2 draw D A indefinitely; on C as centre with C B as radius describe the arc B A.

To Find the Angle with which to Square the Wreath-piece at Both Joints:—Prolong C 2 to F indefinitely; on 2 as centre describe an arc touching the inclined line C B and at F; connect F G: then the bevel at F contains the angle required.

Fig. 4. Face-mould from Plan Fig. 3; also Squaring of the Wreath-piece at Both Joints.—Draw the line A A indefinitely; let J A and J A each equal J A of Fig. 3; make J C at right angles to J A and equal to J C of Fig. 3; connect C A and C A; prolong C A to S and C A to R, each indefinitely; make C H and C H each equal C H of Fig. 3; make A R equal D R or J T of Fig. 2, for straight wood; make A S equal B S or A S of Fig. 2, this being one half the straight between the quarter-circles of which this cylinder is composed; through H and H parallel to the level line J C draw M K, M K; make H K and H M equal L K and L M of Fig. 3; make J I and J N each equal J I and J N of Fig. 3; through A at both ends draw K W; make A W, A W each equal A K; the joints S and R are made at right angles to the tangents; from K and W draw lines parallel to the tangents, touching the joints; through W M C M W of the convex and K N K of the concave trace the curved edges of the face-mould The angle with which to square the wreath piece at the centre joint S and joint R is contained in the bevel at F of Fig. 3. The development of the centre line is explained in detail at Plate No. 20, Fig. 1, quarter-circle A C, and A Y E of Fig. 2. This case of face-mould, Fig. 4, is given in detail at Plate No. 11. This plan of stairs is given at Plate No. 7, Fig. 2.

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* A riser is calculated as set in a cylinder three inches more or less from the chord-line to the face of the regular tread, and not from the chord-line to any point of the cylinder to which the riser may be curved.

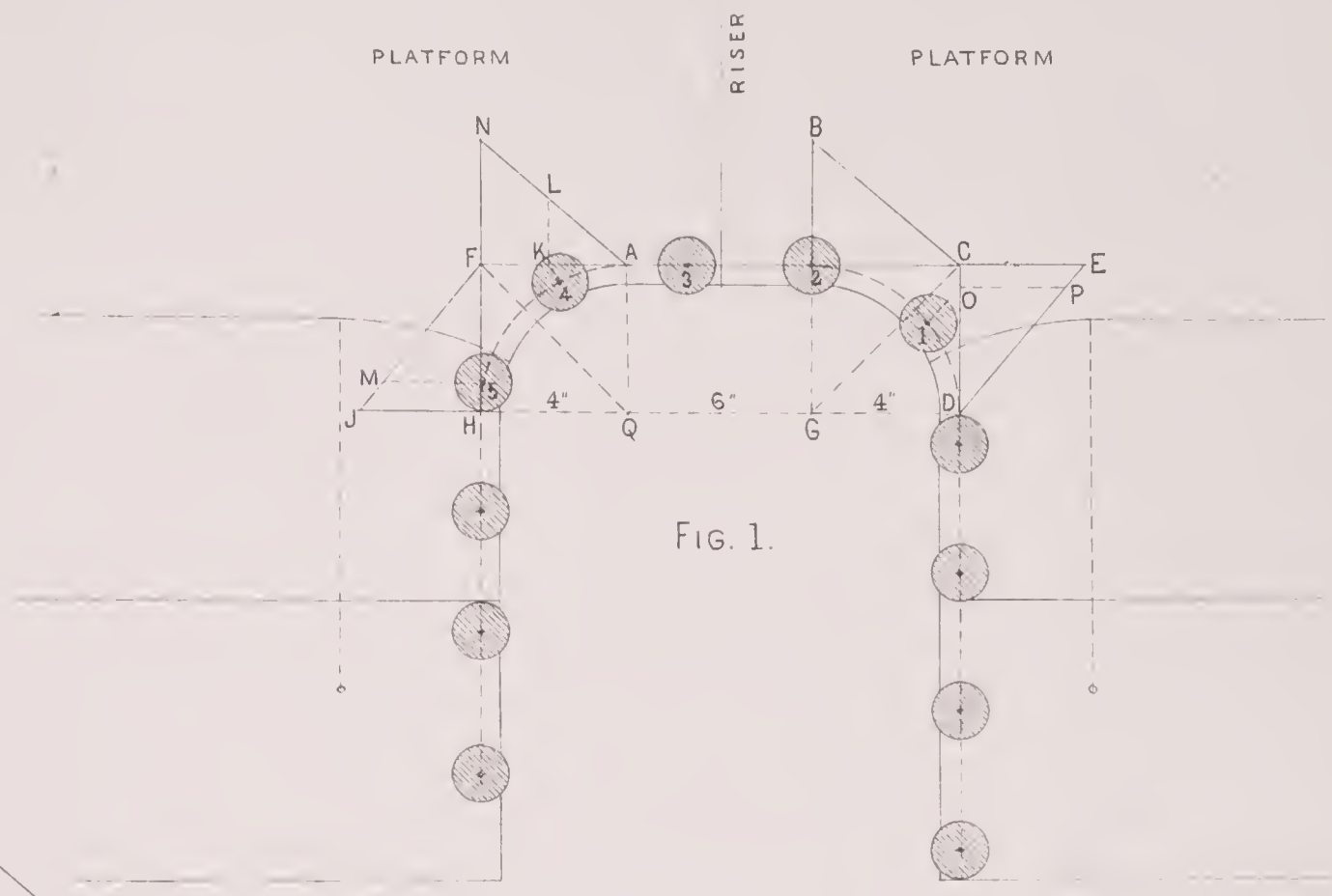


FIG. 1.

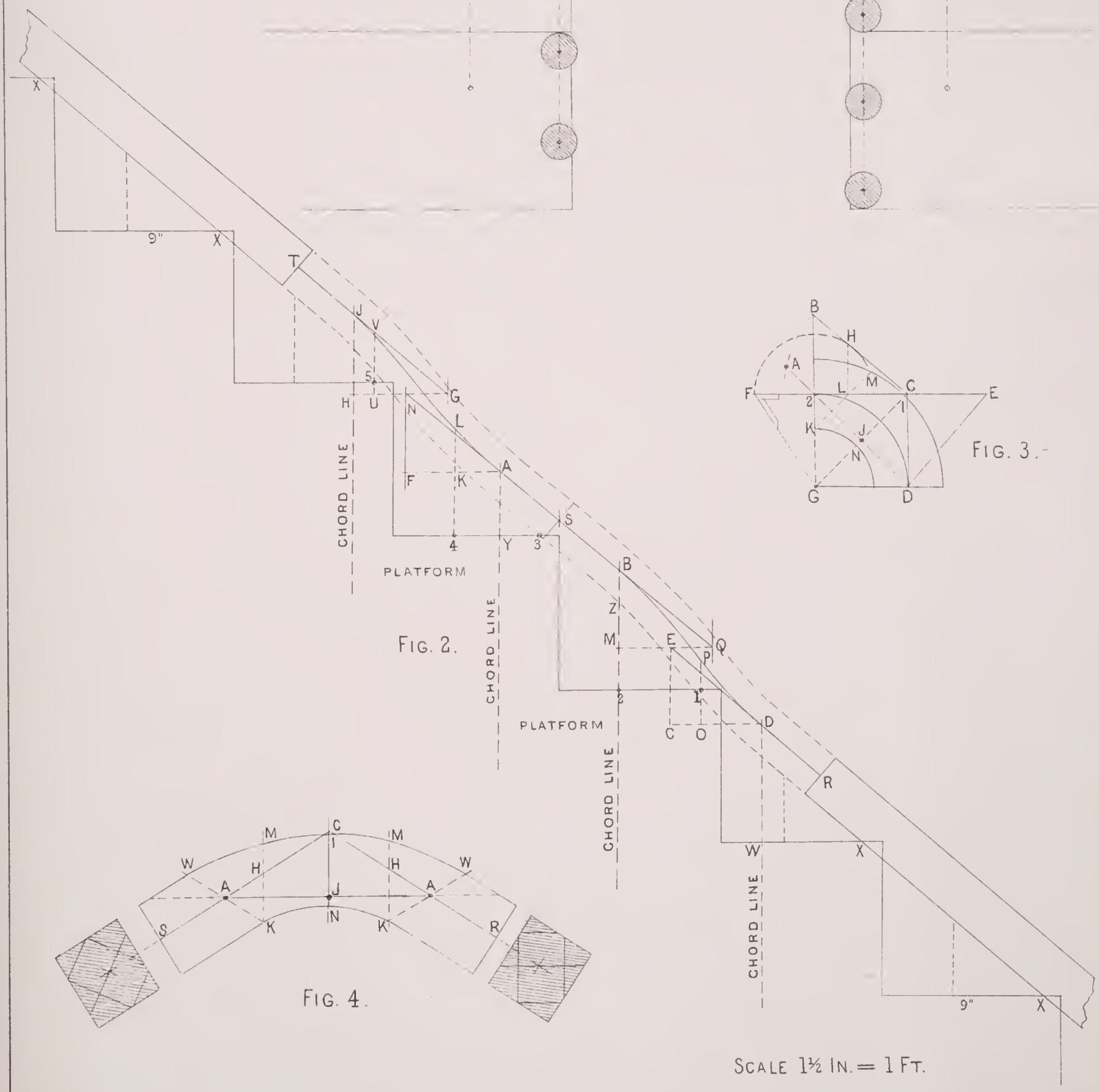


FIG. 2.

FIG. 3.

FIG. 4.

SCALE 1½ IN. = 1 FT.

PLATE 40.

Fig. 1. Plan of Half-turn Platform Stairs with 15″ Cylinder, the Risers Landing on and Starting from the Platform set in the Cylinder 7½″, its Whole Depth.—This plan is given at PLATE No. 7, FIG. 1. Describe the centre line of rail, and draw the tangents A E, E X. Space the balusters as required. Before proceeding further in the preparation of this plan for drawing the required face-mould it is necessary to set up the elevation.

Fig. 2. Elevation of Tread and Rise as given at the Plan and as Figured.—Place the chord-lines, of which there are two, in position as shown on the plan FIG. 1. Let the bottom line of rail pass through the centres of short balusters at O O, and draw the centre line of rail D C and G K each parallel to O O. From the first chord-line A make A E equal A E of FIG. 1; parallel to a rise-line draw E C; at A draw A E at right angles to the chord-line; make J G equal A E; draw G X parallel to the rise-line; from G draw G J at right angles to G X; from C draw C X parallel to the line of platform; divide G X at F in two equal parts.

To Prepare the Plan Fig. 1 as Required to Measure for Drawing a Face-mould.—Prolong X E to N and to C; make E C equal E C of FIG. 2; connect C A; prolong J X to F and to I; make X F equal X F of FIG. 2; connect F E; make E D equal X F; draw D B parallel to E A; make B K parallel to E C; connect K J, which is the level line; parallel to J K draw Y 2; parallel to J A draw 2 W; parallel to J K draw E M, U V and X S; parallel to J X draw V R; at right angles to J X draw A H and X Z, both indefinitely; on E as centre with E F as radius describe the arc F Z; again, on E as centre with C A as radius describe an arc at H; connect H Z.

To Find the Angle with which to Square the Wreath-piece at the Joint over X:—Make X N equal X G; connect N M: then the bevel at N will contain the angle required.

To Find the Angle with which to Square the Wreath-piece at the Joint over A:—Make J I equal K Q; connect I A: then the bevel at I will contain the angle sought.

Fig. 3. Face-mould from Plan Fig. 1, also Showing the Squaring of the Wreath-piece at Both Joints.—Draw the line Z H; make Z O and O H equal the same at FIG. 1; on Z as centre with F E of FIG. 1 as radius describe an arc at C; on H as centre with A C of FIG. 1 as radius intersect the arc at C; on O as centre with O E of FIG. 1 as radius test the intersection of the arcs at C; connect Z C, H C and O C; prolong C H to D; make H D equal D A or H K of FIG. 2; make the joints D and Z at right angles to the tangents; make H W B equal A W B of FIG. 1; make C R equal E R of FIG. 1; parallel to O C draw Z S. R U, and through B, L 4 and W Y; make W Y equal 2 Y of FIG. 1; make B L and B 4 equal K L and K 4 of FIG. 1; make C P equal E P of FIG. 1; make R U equal V U of FIG. 1; make Z S equal X S of FIG. 1. Through H draw Y T; make H T equal Y H; through Z draw U J; make Z J equal Z U; draw lines from T and Y parallel to the tangent touching joint D. Through T L P S J of the convex and Y 4 O U of the concave trace the curved edges of the face-mould. The slide-line is at right angles to the level line O C. The angle for squaring the joint Z is taken by the bevel N of FIG. 1, and for squaring joint D by the bevel I of FIG. 1.

Fig. 4. Elevation of Step and Rises at the Starting, Set up for the Purpose of Finding what Position the Bottom Riser should take next to the Chord-line of the Cylinder when the Wreath-piece is Treated in the Simplest Manner, with the Over-wood all to be Removed from the Top.—Let the bottom line of rail pass through the centres of short balusters X X. Set off the thickness of rail X E, and draw E H parallel to X X; let X D be the thickness of plank, out of which the wreath-piece is to be worked. Make the line A F pass through the centre of X D and parallel to XX; make B C four inches and C A half the thickness of rail. The intersection of the line A J at its given height with the centre line F A at A fixes A as the centre of the rail at the centre of the plank, and the distance from A to the chord-line J must be 8¼″, equal to J A of FIG. 1.

Fig. 5. Plan of Cylinder Connecting Step and Hand-rail at the Bottom of this Flight of Stairs.—Let the chord line H of the cylinder be set at the same distance from the bottom riser as shown at the elevation FIG. 4.

To Prepare the Plan for Drawing a Face-mould:—Draw the tangents H J and J K; from the centre D describe the plan of rail. Set the pitch-board with the tread on the line H J, and mark the pitch-line J Q; prolong D H to Q; parallel to K J draw L N, V O and U P.

Fig. 6. Face-mould from Plan Fig. 5, also Squaring the Wreath-piece at Both Joints.—Draw Y J, J K at right angles; make J N O P Q equal the same at FIG. 5; make J K equal J K of FIG. 5. Through K parallel to J Y draw X L; through N O P Q Y draw lines parallel to J K indefinitely; make N M, O W, P S and Q equal Y M, X W, Z S and H R of FIG. 5. Make O V, P U and Q T equal X V, Z U and H T of FIG. 5; draw lines from T and R to the joint Y parallel to Q Y; through X I M W S R of the convex and L V U T of the concave trace the curved edges of the face-mould. The wreath-piece at the joint K is squared by the use of the pitch-board as shown. The joint at Y is square, and E D is the over-wood as shown at E D of FIG. 4. *Face-mould* FIG. 6 *is treated in detail at* PLATE No. 10. *Face-mould* FIG. 3 *is explained in detail at* PLATE No. 12. *The development of the centre line at* FIG. 2 *of wreath-pieces is given in detail at* PLATE No. 20, FIG. 3, *quarter-circle* Q V, *and* FIG. 4, Q Y.

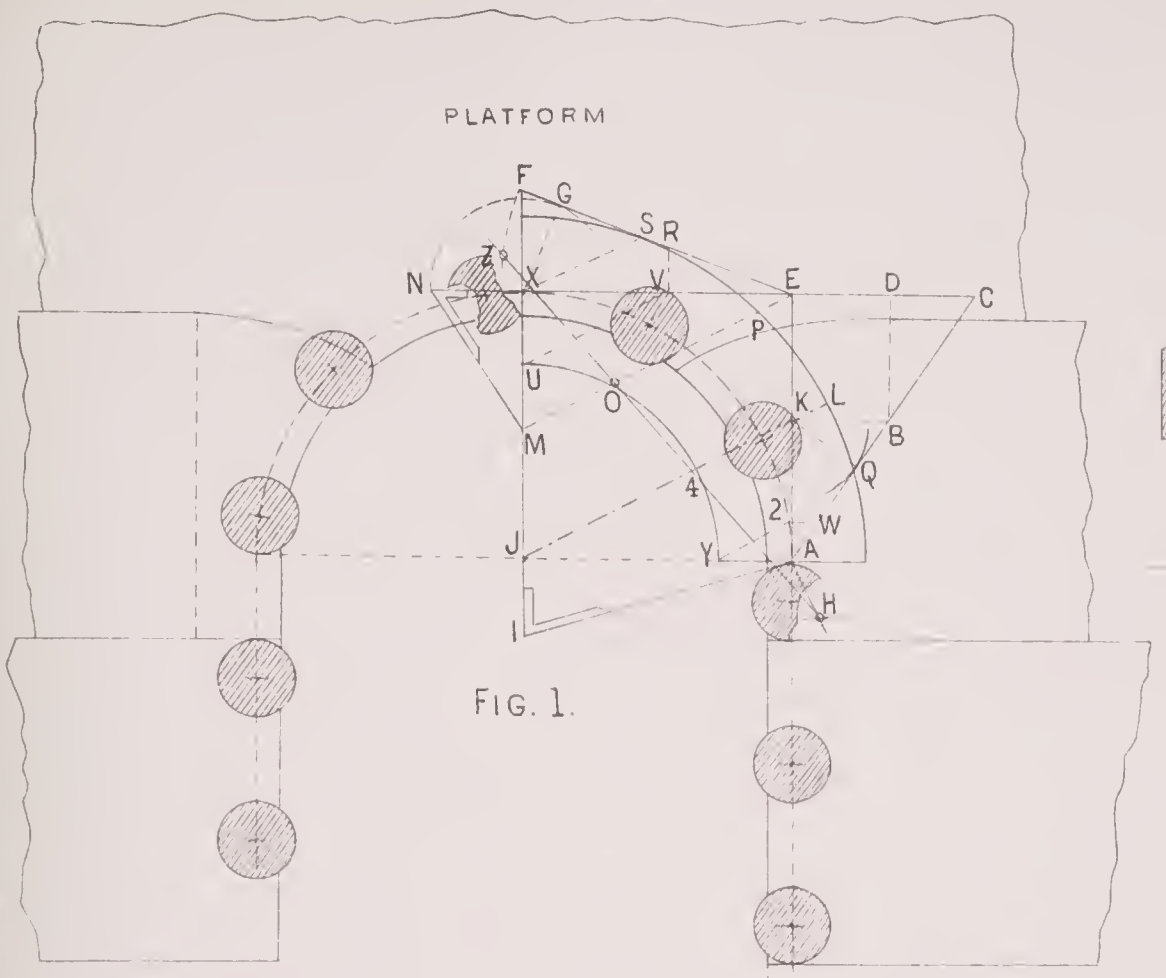


FIG. 1.

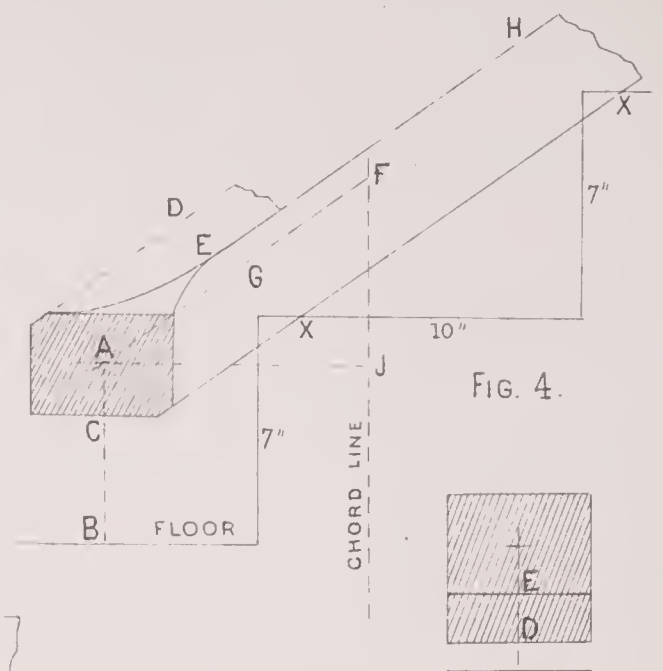


FIG. 4.

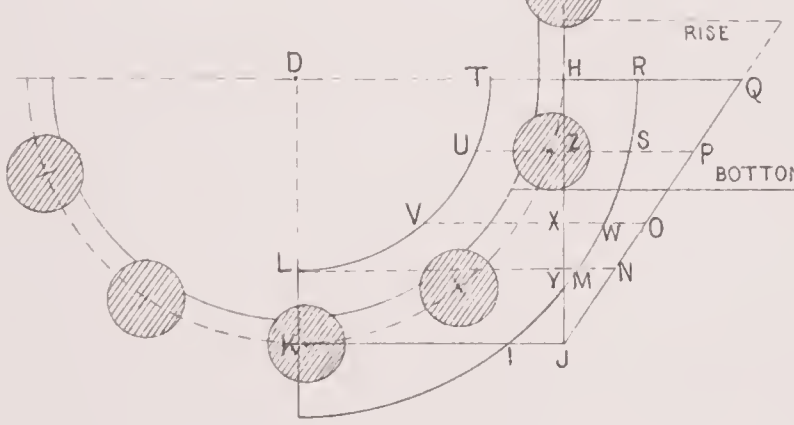


FIG. 5.

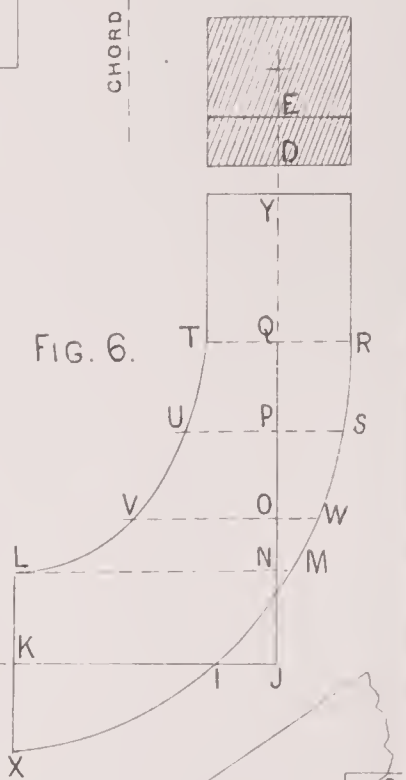


FIG. 6.

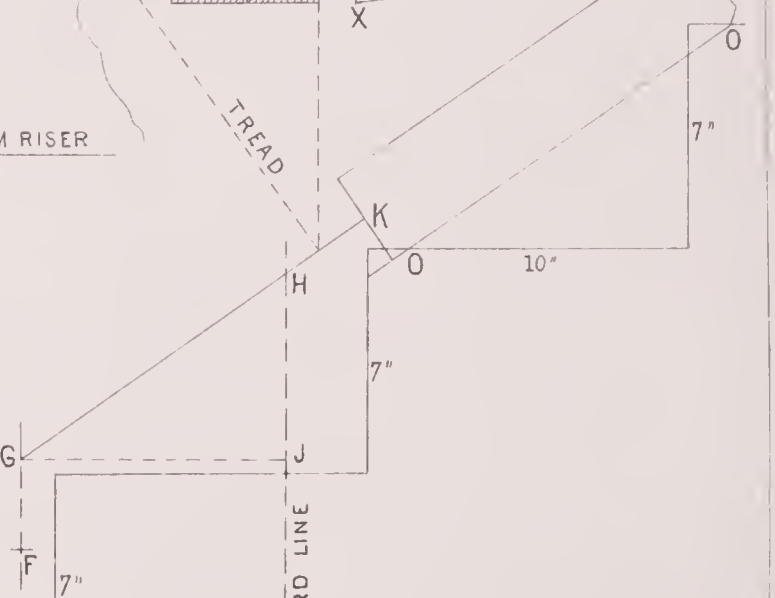
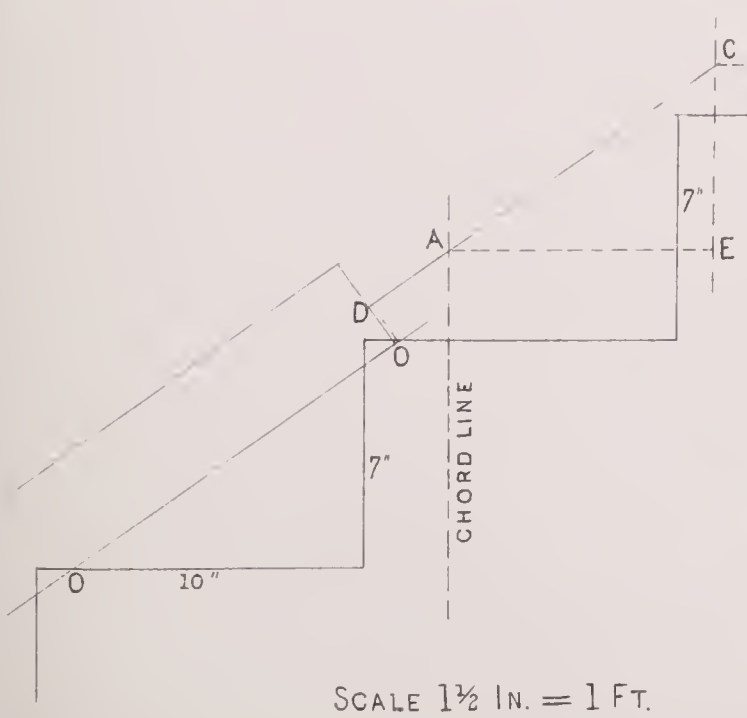


FIG. 2.



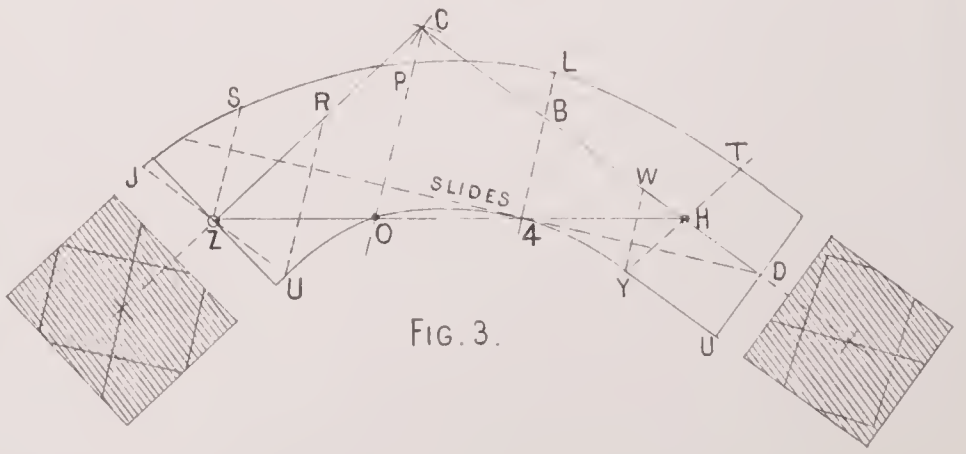


FIG. 3.

SCALE 1½ IN. = 1 FT.

PLATE 41.

Fig. 1. Plan of Stairs with Two Quarter Platforms and a Tread between, All Connected with, and Dividing Equally, a 10″ Cylinder.—This plan of stairs is given at PLATE No. 5, FIG. 9. Describe the centre line of rail, and space the balusters as required. Draw the tangents A B, B E, E G and G J to the centre line of rail A E J. To find the angles of inclination of these tangents, and other points of measurement by which to get the lengths of balusters, it is necessary to set up an elevation.

Fig. 2. Elevation as given at Plan Fig. 1 and as Figured.—Measure the three treads in the cylinder on the centre line, and, as before explained, of treads situated in curves. Let the bottom line of rail pass through the centres of short balusters at X, 1 below and X X above; draw the centre line of rail L C parallel to X, 1, and the centre line F G parallel to X X; make A B and J G equal A B and J G of FIG. 1. From A at right angles to the chord-line draw A B, and from G at right angles to the chord-line draw G J; from C at right angles to H E draw C E; divide E J at D in two equal parts. Place the centres of balusters 1, 2, 3 as at the plan, and draw lines through each parallel to the rise-lines and indefinitely.

At Fig. 1, to further Prepare for the Development of the Centre Line of Wreath and for the Lengths of Balusters:—Make the angles A C B and J H G equal A C B and J H G of FIG. 2; prolong J G to F, and K E to D; make E D and G F each equal E D of FIG. 2; connect D B; connect F E; make G U equal J H; draw U X parallel to G E; make X W parallel to G F; connect W K, which is the directing level line for the quarter-circle E J; make D N equal B C; draw N L parallel to E B, and L O parallel to E D; connect O K: then O K will be the directing level line for the quarter-circle A E; from the centre of baluster 1 draw 1 S parallel to K O; parallel to B C draw S T; from the centre of baluster 2 draw 2 V parallel to K O; make V M parallel to E D; through the centre of baluster 3 draw 3 Z parallel to K W; make Z Y parallel to G F. At FIG. 2 make S T equal S T of FIG. 1, and V M equal V M of FIG. 1; make Z Y equal Z Y of FIG. 1; through A T M Y H trace the centre line of wreath, and set off each side of the centre half the thickness of rail as shown by the dotted lines. Of the three balusters around this cylinder, only one, No. 3, will require a half inch more length than usual for short balusters. A L and H F are 4″ straight wood to be left on the wreath-pieces above and below the cylinder.

Fig. 3. Plan of Rail and the Centre Line of the First Quarter A E with the Tangents A B and B E, and the Angles of Inclination A C B and B D E, from Fig. 1.—Make D N equal B C; draw N L parallel to E B, and L O parallel to E D; connect O K, the directing level line; parallel to O K draw 4, I, B U, W X and A H; parallel to B C draw X G; parallel to D E draw Y M; at right angles to O K draw A Q indefinitely; and again at right angles to O K draw E R indefinitely; on B as centre with B D as radius describe the arc D R; on B again as centre with C A as radius describe an arc at Q; connect Q R.

To Find the Angle with which to Square the Wreath-piece at the Joint over E:—Prolong B E to V; make E V equal N P; connect V K: then the bevel at V will contain the angle required.

To Find the Angle with which to Square the Wreath-piece at the Joint over A:—At U draw U T at right angles to K A; make U T equal B F; connect T A: then the bevel at T will contain the angle sought.

Fig. 4. Face-mould from Plan Fig. 3; also Squaring the Wreath-piece at Both Joints.—Draw the line Q R; make R S and S Q equal the same at FIG. 3. On Q as centre with A C of FIG. 3 as radius describe an arc at B; on R as centre with D B of FIG. 3 as radius intersect the arc at B; from S test the intersections at B by S B of FIG. 3; connect R B, Q B and S B; prolong B Q to C; make Q C equal A L of FIG. 2; make the joint C and R at right angles to the tangents; make Q G equal A G of FIG. 3; make R M L equal D M L of FIG. 3; parallel to S B draw Q H, G W, L J and 4, I; make M I and M 4 equal Y I and Y 4 of FIG. 3; make L J and B Z Y equal O J and B Z Y of FIG. 3; make G W and Q H equal X W and A H of FIG. 3; through R draw 4 P; make R P equal R 4; through Q draw W F; make Q F equal Q W; from F and W draw lines to joint C parallel to B C; through F H Z I P of the convex and W Y J 4 of the concave trace the curved edges of the face-mould. The slide-line is drawn at right angles to the level directing line S B. Joint R of the wreath-piece is squared by the bevel at V of FIG. 3, and joint C by the bevel at T of FIG. 3. *The face-mould is explained in detail at* PLATE No. 12. The development of the centre line of the wreath-piece is explained at PLATE No. 20; the quarter-circle Q V of FIG. 3, and Q Y of FIG. 4.

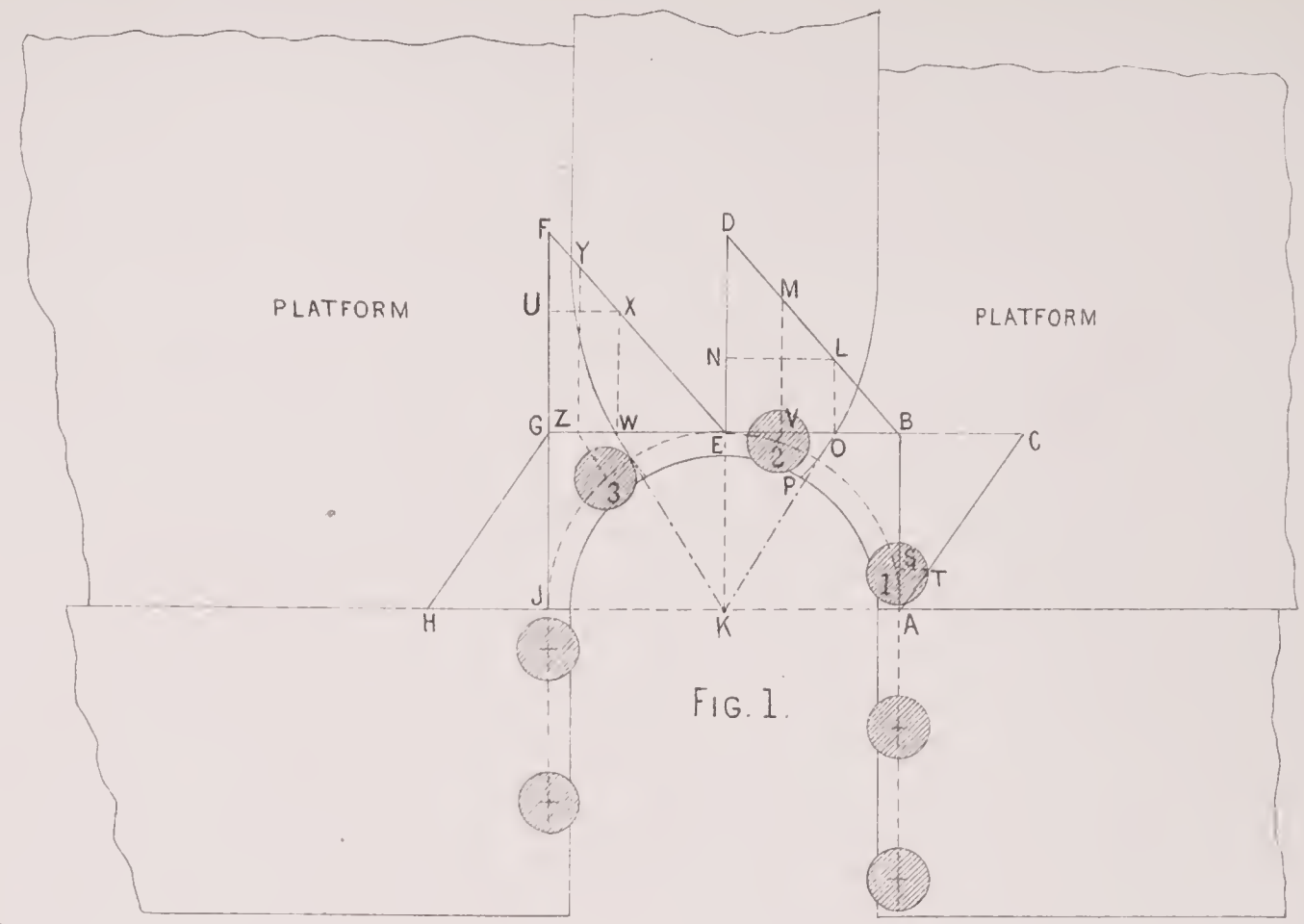


FIG. 1.

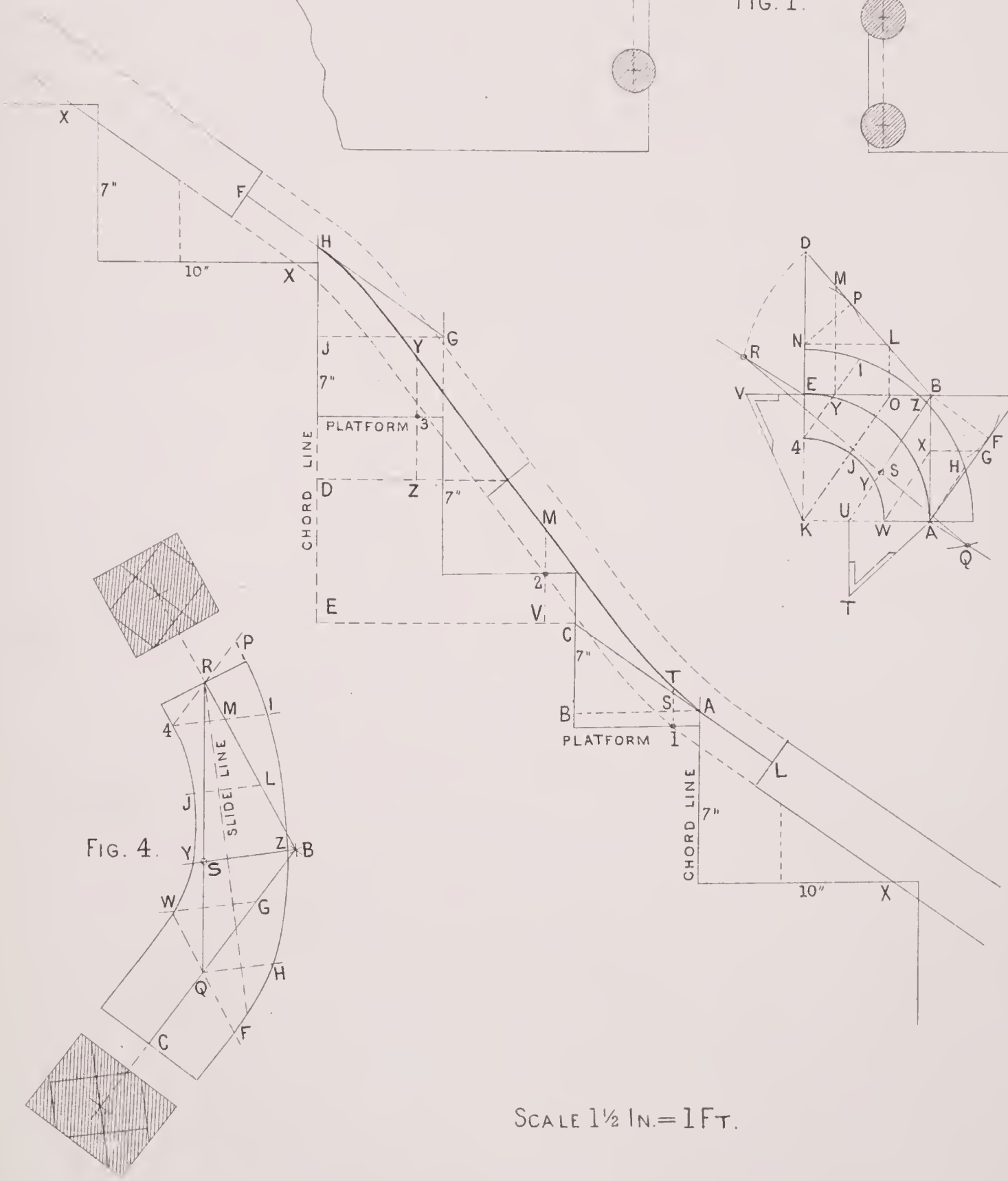


FIG. 3.

FIG. 4.

SCALE 1½ IN. = 1 FT.

PLATE 42.

Fig. 1. Plan of Landing and Starting Two Flights, Both in Connection with a 12″ Cylinder.—This plan is given at PLATE No. 6, FIG. 3. The centre line of the rail may be described, the balusters spaced, and the tangents to the centre line drawn; then, to find the angle of inclination of these tangents, an elevation of the plan must be made.

Fig. 2. Elevation of Plan as given at Fig. 1 and as Figured; also Development of the Centre Line of Wreath.—In setting up the elevation, the treads in the cylinder must be measured between chord-lines on the centre line of rail, each in two parts, so as to get practically near enough to the stretch-out of the circle. Draw the chord-lines in the position given on the plan, and parallel to the rise-lines. Place the centre of balusters as given on each step of the plan, and through these centres draw lines parallel to the rise-lines indefinitely. Let the bottom line of rail above and below each pass through the centres of short balusters X X; draw the centre line of rail at I G and T B each parallel to X X. Make the distance from the chord-line A W to B C equal the tangent A C of FIG. 1; draw B C parallel to A W; at A draw A C at right angles to A W; make the distance from the chord-line J S to G equal the tangent H G of FIG. 1; draw G F parallel to J S; at G draw G H at right angles to J S; from B draw B F parallel to the line of floor; divide G F in two equal parts at D; transfer the angle A B C to A B C of FIG. 1. The three remaining tangents all happen in this case to have the same angles of inclination,* so that the angle H J G may be placed at E D C, G F E and H J G, FIG. 1. Make D H of FIG. 1 equal C B; draw H J parallel to E C; make J V parallel to E D; connect V K, which is the directing level line for the quarter E A. The directing level line for the quarter E H—that quarter having a common angle of inclination—is a line drawn from G to K. From the centre of baluster 1 draw 1 L parallel to C B; from the centre of baluster 2, parallel to K V, draw 2, O; parallel to E D draw O K and 3 M; from balusters 4 and 5 draw 4 N and 5 Q parallel to K G; parallel to G F draw N P; parallel to H J draw Q R. At FIG. 2 make Z R over baluster 5 equal Q R of FIG. 1. Make N P over baluster 4 equal N P of FIG. 1; make E M over baluster 3 equal 3 M of FIG 1; make B O equal O K of FIG. 1; parallel to B F draw O K; make V L over baluster 1 equal 1 L at FIG. 1; through J R P M K L A trace the centre line of wreath; set off each side of the centre half the thickness of rail as shown by the dotted lines.

To Find the Lengths of Balusters:—For example, take baluster 3; 3 U measures $6\frac{3}{4}''$, which must be added to $2'.2''$, the length of short balusters X X, and this makes the length of that baluster, measured along its centre from top of step to under side of rail, $2'.8\frac{3}{4}''$.

Fig. 3. Plan of Rail for Quarter-circle, Centre Line A E, Fig. 1, with Angles of Inclination—over Tangents—A B C and C D E; also the Directing Level Line V K as Transferred from Fig. 1.—Parallel to K V draw Z 5, C Q and Y W; parallel to E D draw 4 F; parallel to C B draw X N; at right angles to V K draw E T and A O indefinitely; on C as centre with C D as radius describe the arc D T; again on C as centre with B A as radius describe an arc at O; connect O T.

To Find the Angle with which to Square the Wreath-piece at the Joint over E:—Prolong C E to S; make E S equal H G; connect S K: then the bevel at S contains the angle required.

To Find the Angle with which to Square the Wreath-piece at the Joint over A:—From Q draw Q P at right angles to K A; make Q P equal C R; connect P A: then the bevel at P contains the angle sought.

Fig. 4. Face-mould from Plan Fig. 3; also Showing the Squaring of Wreath-piece at Both Joints.—Draw the line A T indefinitely; make T U and U A equal T U and U O of FIG. 3. On T as centre with C D of FIG. 3 as radius describe an arc at B; on A as centre with A B of FIG. 3 as radius intersect the arc at B; with U C of FIG. 3 test the intersection of the arcs at U B; connect T B, B A and U B; make B F equal C F of FIG. 3; make B N equal B N of FIG. 3; parallel to U B through F and N draw 5 Z and W Y; make F Z and F 5 equal 4 Z and 4, 5 of FIG. 3; make B I U equal C I U of FIG. 3; make N Y and N W equal X Y, X W of FIG. 3; through A draw Y C; make A C equal A Y; through T draw Z G; make T G equal T Z; make A J for straight wood equal A T of FIG. 2; make the joints J and T at right angles to the tangents; from Y and C draw lines to joint J parallel to B J; through G 5 I W C of the convex and Z U Y of the concave trace the curved edges of the face-mould. The wreath-piece is squared at joint J by the bevel at P of FIG. 3, and joint T is squared by the bevel at S of FIG. 3. The slide-line is drawn at right angles to the level line U B. A face-mould of this kind is explained at PLATE No. 12, and the development of the centre line of such a wreath-piece as this is given at PLATE No. 20; quarter-circle Q V of FIG. 3, and Q Y of FIG. 4.

Fig. 5. Plan of Rail for Quarter-circle E H of Fig. 1, with Angles of Inclination over Tangents E F G and G J H, as Transferred from E H of Fig. 1.—Connect G K; parallel to G K draw L Y; parallel to G F draw Z D; through H and E draw H W indefinitely; on G as centre with E F as radius describe an arc at W.

To Find the Angle with which to Square the Wreath-piece at Both Joints:—Prolong G H to N; make H N equal H R; connect N K: then the bevel at N will contain the angle required.

Fig. 6. Face-mould from Plan Fig. 5; also Showing the Squaring of the Wreath-piece at Both Joints.—Draw the line W, W; make S W, S W each equal S W of FIG. 5; draw S G at right angles to S W; make S G equal S G of FIG. 5; connect G W and G W; prolong G W to A; make W A for straight wood equal J I of FIG. 2; make the joints A and W at right angles to the tangents; make G D, G D each equal F D of FIG. 5; through D and D draw L Y and L Y parallel to G S; make D Y and D L at both sides of the centre each equal Z Y and Z L of FIG. 5; through W and W draw L M and L M; make W M equal W L; make G T equal G T of FIG. 5; through M Y T Y M of the convex and L S L of the concave trace the curved edges of the face-mould; from L and M draw lines to joint A parallel to G A. A face-mould of this kind is explained in detail at PLATE No. 11, and the development of the centre line of wreath-piece at PLATE No. 20, FIG. 1, quarter-circle A C, and FIG. 2, A E.

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* *If the height* **G F** *had been more or less than twice the height* **H J**, *then the face-mould for the quarter-circle* **H E** *would have been of the same kind as that of* FIG. 4.

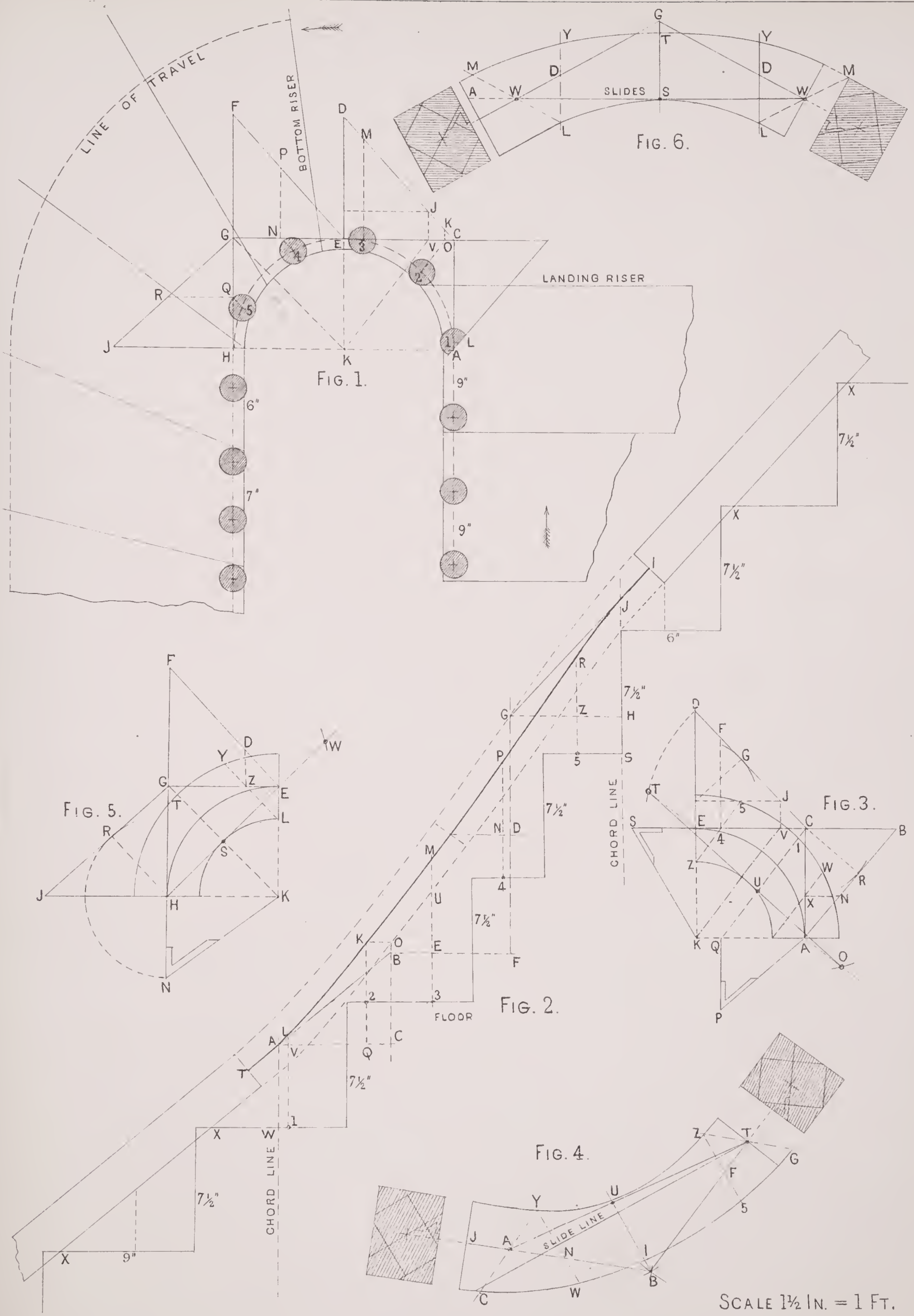

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

SCALE 1½ IN. = 1 FT.

PLATE 43.

Fig. 1. Plan of the Starting of a Staircase with One Parallel Step at the Centre of a 15″ Cylinder, together with a Quarter Platform.—This plan is given at PLATE No. 7, FIG. 9. The centre line of rail may be described, the tangents drawn, and the balusters spaced as required; but to find the angle of inclination over the plan tangents, etc., the elevation must first be set up.

Fig. 2. Elevation of Treads and Rises as given at Plan Fig. 1, and as Figured.—Let the bottom line of rail be drawn through the centres of short balusters X X, and draw the centre line of rail A N parallel to X X. Place the chord-line H J parallel to the rise-line, and in position as at the plan; make J G equal J F at FIG. 1; draw F G parallel to the rise-line, and at the intersection G draw G J at right angles to the rise-lines. Make F D equal F E of FIG. 1; draw E D parallel to the rise-line; at the intersection D draw D F at right angles to the rise-line; make E C equal E C of FIG. 1; make 1 B equal 1 B of FIG. 1; draw B N at right angles to the line of floor; make B K equal 4″, and K N half the thickness of rail; draw N E parallel to the floor-line. Place the centre of each baluster on the treads as numbered, and as fixed around the centre line of rail at the plan, and draw lines through each parallel to the rise-lines indefinitely. At FIG. 1 make the angles of inclination J H F, F G E and E D C all equal J H G of FIG. 2; parallel to A D through the centre of baluster 2 draw N M; from the centre of baluster 1 draw 1 L parallel to A D; draw I K parallel to A D. Connect F A; from 3 parallel to A F draw 3, 0; parallel to F G draw O R; parallel to A F draw 4 Q; parallel to J H draw Q P. Again at FIG. 2, baluster 1, make V L equal V L of FIG. 1; at baluster 2 make S M equal S M of FIG. 1; at baluster 3 make O R equal O R of FIG. 1; at baluster 4 make Q P equal Q P of FIG. 1. Through the points N L M R P H trace the centre line of wreath-piece; set off half the thickness of rail each side of the centre as shown by the dotted lines. To find the length of any of these balusters proceed as before directed.

Fig. 3. Face-mould from Plan Fig. 1, Quarter-circle B E, also Showing the Squaring of the Wreath-piece at Both Joints.—Draw the lines D C and C H at right angles. Make C D equal C D of FIG. 1; make C B equal C B of FIG. 1; make B H equal 3″ for straight wood. Make C K M equal C K M of FIG. 1; draw K I parallel to C B; draw Q N through M parallel to C B; draw the joint D parallel to C B; draw I T parallel to D C; make the joint at H at right angles to C H; from T and I parallel to C H draw lines to the joint H; make C A and K J each equal C H and T U of FIG. 1; make M N and M Q each equal S N and S W of FIG. 1; make D Y and D X each equal E Y of FIG. 1. Through T A J Q X of the convex and I N Y of the concave trace the curved edges of the face-mould. *The angle with which to square the wreath-piece at joint* H *is contained in the bevel at* D *of* FIG. 1. The sides of the wreath-piece at joint D are at right angles to the face of plank, and the over-wood is taken off both surfaces of the plank equally. *Hand-rails much thicker than two thirds of their width require considerably greater width and thickness of stuff to work out the wreath-piece.*

Fig. 4. Plan of Quarter-circle taken from J E of Fig. 1, together with Angles of Inclination over the Plan Tangents Lettered Alike.—Connect F K; through E and J draw E L indefinitely; on F as centre with F H as radius describe the arc H L. Parallel to F K draw Y D and V B; parallel to F G draw Z X and N C.

To Find the Angle with which to Square the Wreath-piece at Both Joints:—Prolong F J to P indefinitely; make J P equal J M; connect P K: then the bevel at P will contain the angle required.

Fig. 5. Face-mould from Plan Fig. 4; also Showing the Squaring of the Wreath-piece at Both Joints, and the Additional Width Required by a Form of Hand-rail of this Proportion.—Draw the line E H indefinitely; make W H and W E each equal W L of FIG. 4. At right angles to E H draw W G; make W G equal W F of FIG. 4; connect G E, G H and G W; make G C X, G C X equal the same of FIG. 4. Through G C X each side of the centre parallel to G W draw D Y, B V; make X Y and X D at each end equal Z Y and Z D of FIG. 4; make C K V and C B each side of the centre equal N K V and N B of FIG. 4; make G T S U equal F T S U of FIG. 4; through H and through E draw Y O; make E O equal E Y; make H O equal H Y; make H A equal H A of FIG. 2; from O and Y draw lines to joint A parallel to G A; through O D B T B D O of the convex and through Y V U V Y of the concave trace the curved edges of the face-mould. The joints A and E of the wreath-piece are squared by the angle contained in the bevel at P of FIG. 4. By laying out the squaring of the joint as here given, the thickness and width of wood required to work out the wreath-piece are found,* and with half this width as radius on each of the centres E K S K H A describe arcs of circles, touching which the edges of a parallel pattern may be traced; or no pattern need be made, and the increased width of wood required may be scribed from the edges of the face-mould on the plank. *The development of a centre line of wreath is given in detail at* PLATE No. 20, FIGS. 1 and 2. *Face-mould* FIG. 3 *is given in detail at* PLATE No. 10. *Face-mould* FIG. 5 *is given in detail at* PLATE No. 11.

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* See PLATE 56, FIGS. 6 and 7.

FIG. 2.

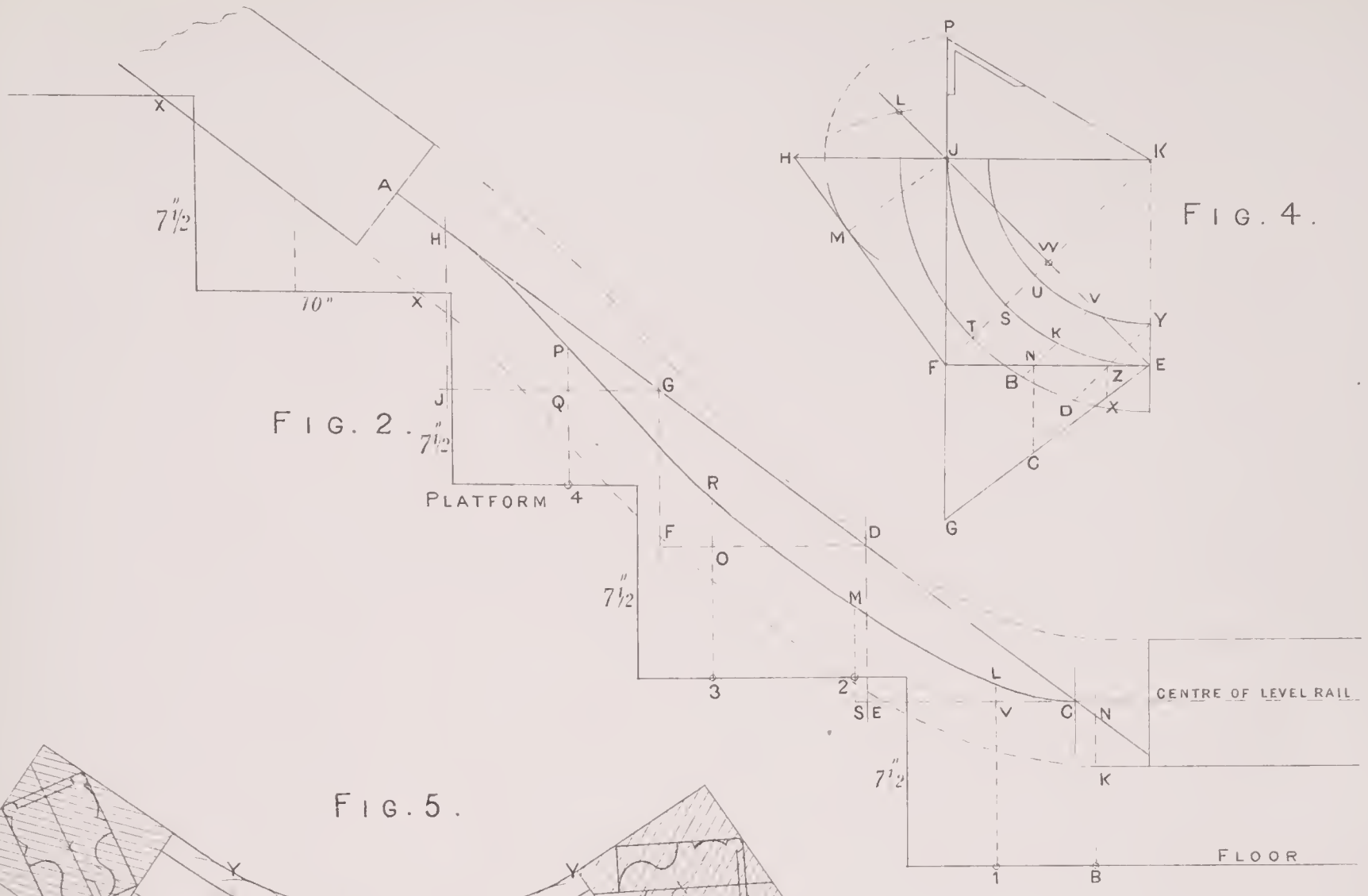


FIG. 4.

FIG. 5.

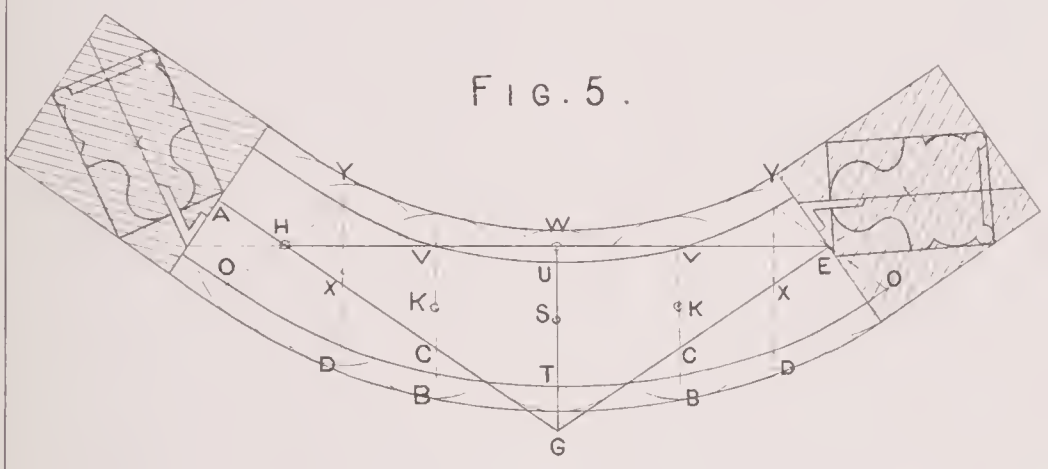


FIG. 1.

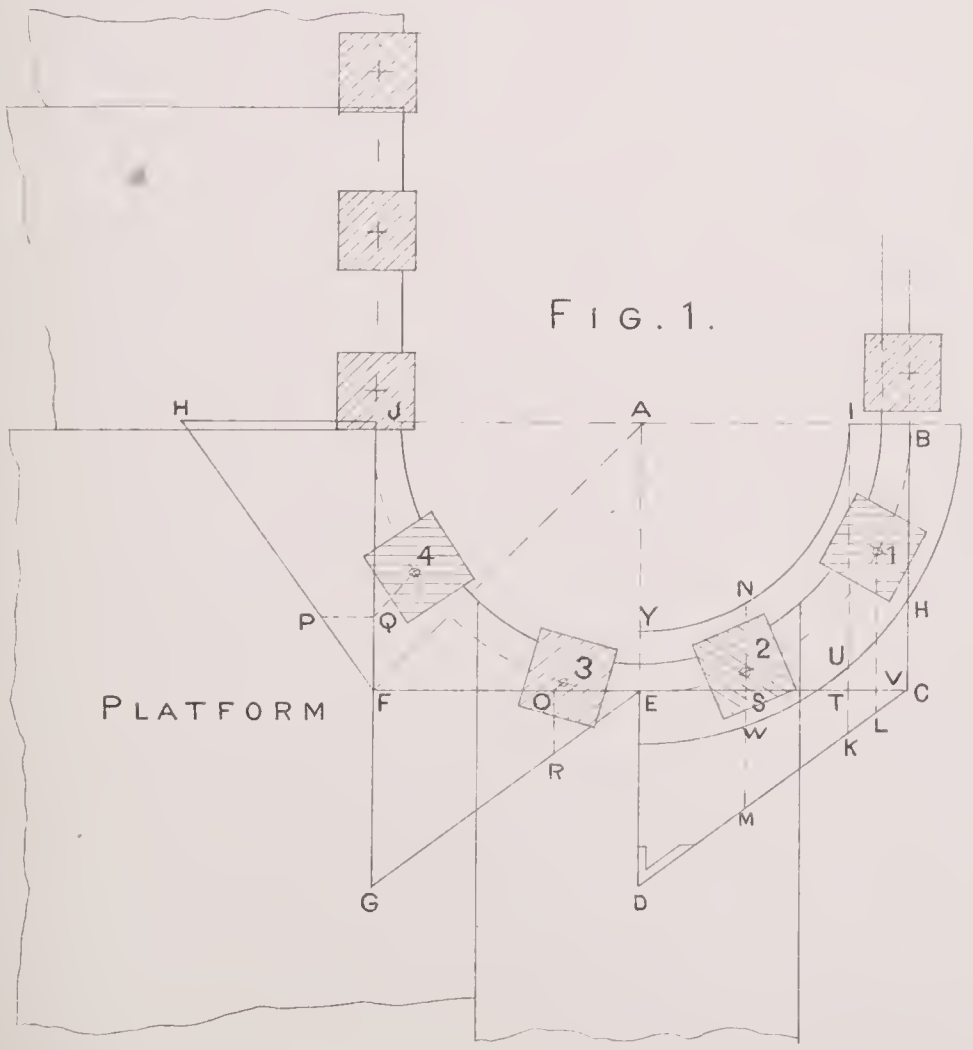
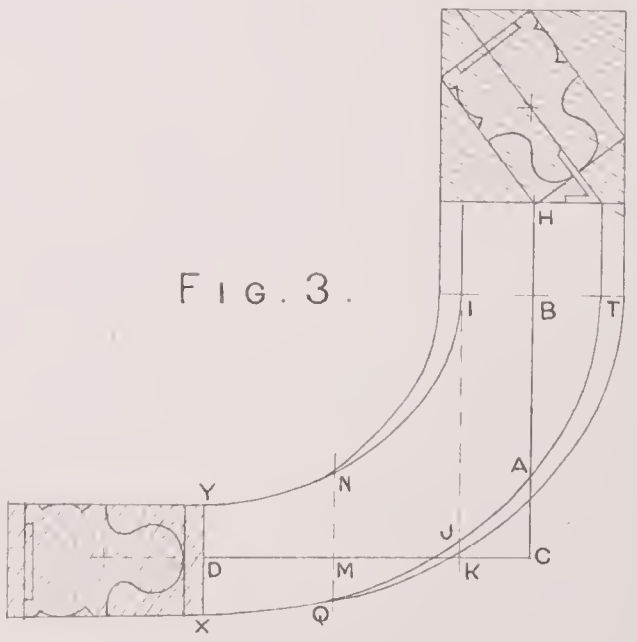


FIG. 3.



SCALE 1½ IN = 1 FT.

PLATE 44.

Fig. 1. A Superior Plan of Starting a Stairs making a Quarter-turn, with Parallel Steps and Platform, in about the Same Space Required when Planned with Winders.—This plan is given at PLATE No. 7, FIG. 8. Describe the plan of rail and its centre line; draw the tangents D B and B A, and space the balusters as required; then before proceeding further the elevation must be set up.

Fig. 2. Elevation of Treads and Risers as given at Plan Fig. 1 and as Figured; also the Development of the Centre Line of the Wreath.—Draw the treads and rises as shown on the plan, taking the measure—on the centre line of the rail—of each tread in two parts as before explained. Place the chord-line A F as at S on the plan FIG. 1. Let the bottom line of rail rest on X X, the centres of short balusters; draw the centre line of rail Q E indefinitely and parallel to X X; make F E equal D B of FIG. 1; draw E G parallel to the chord-line; make 1 S equal four inches, and S B half the thickness of rail; parallel to the floor-line draw B D; make D B equal G C: then B is a fixed point, and E is also a fixed point at the place where the line G E intersects the centre line of rail T A. Connect E B; and where the line C D intersects the line E B at C, draw the line C G at right angles to C D. 1 Z equals 1 A of FIG. 1; make Z V parallel to 1 B. Place the centre of each baluster on the steps in position, and number them as at the plan, drawing lines through each parallel to the rise-lines indefinitely. Let A T be three inches for straight wood to be put on that end of the wreath-piece. At FIG. 1 make the angle D C B equal D C B of FIG. 2; parallel to E C through 3 draw N G, and from H draw H F parallel to A B.

Fig. 3. Plan of Rail Quarter-circle D S of Fig. 1, with Centres of Balusters 4, 5 and 6 in Place on the Centre Line.—Make the angle F A E equal F A E of FIG. 2; make the angle E H J equal G E C of FIG. 2; make E P equal F A; draw P Q parallel to E J; draw Q T parallel to H E; connect T N, the directing level line; parallel to T N draw X I, E Y, 5, 2 and W V; parallel to E H draw 2 R and 4 U; parallel to F A draw O C. At FIG. 2 baluster 1 happens to be at the point B; at baluster 2 make N K equal I F of FIG. 1; at baluster 3 make J H equal J G of FIG. 1; at baluster 4 make L U equal 4 U of FIG. 3; at baluster 5 make P R equal 2 R of FIG. 3; at baluster 6 make O Q equal O C of FIG. 3; through V K H U R Q A trace the centre line of the wreath. Set off each side of the centre half the thickness of rail as shown by the dotted lines. To find the length of balusters proceed as before directed. Again, at FIG. 3, parallel to F E draw C G; at right angles to T N draw F L and J K; on E as centre with E A as radius describe the arc A L; again, on E as centre with H J as radius describe an arc at K; connect K L.

To Find the Angle with which to Square the Wreath-piece at the Joint over J:—Prolong F N to M; make N M equal T S; connect M J: then the bevel at M contains the angle sought.

To Find the Angle with which to Square the Wreath-piece over Joint F:—Prolong E F to D; make F D equal G B; connect D X; then the bevel at D contains the angle required.

Fig. 4. Face-mould from Plan Fig. 3, also Showing the Squaring of the Wreath-piece at Both Joints.—Draw the line A J indefinitely; make Y A and Y W equal Y L and Y K of FIG. 3; on J as centre with J H of FIG. 3 as radius describe an arc at H; on A as centre with A E of FIG. 3 as radius intersect the arc at H; on Y as centre with Y E of FIG. 3 as radius test the intersection of the arcs at H;* connect J H, H A and Y H; make H Q U equal H Q U of FIG. 3; make H C equal E C of FIG. 3; parallel to Y H through C draw X I; through Q and U parallel to Y H draw Q 8 and V W; make C X and C I equal O X and O I of FIG. 3; make H Z 9 equal E Z 9 of FIG. 3; make Q 8 equal T 8 of FIG. 3; make U W and U V equal 4 W and 4 V of FIG. 3. Through J draw W B; make J B equal J W; through A draw X D; make A D equal A X; make A K equal T A of FIG. 2; make the joints K and J at right angles to the tangents; from X and D draw lines to joint K parallel to H K; through B V Z I D of the convex and W 8, 9, X of the concave trace the curved edges of the face-mould. The slide-line is made at right angles to the level line Y H. *The angle with which to square the wreath-piece at joint* K *is taken by the bevel* D *of* FIG. 3, *and for joint* J *the bevel* M *of* FIG. 3.

Fig. 5. Face-mould from Plan Fig. 1, Quarter A D, which Joins the Level Rail; also Showing the Squaring of the Wreath-piece at the Joints.—Draw the lines B C and B Z at right angles; make B F G C equal the same at FIG. 1; make B A equal B A of FIG. 1; through A draw H E indefinitely and at right angles to B A; parallel to B A draw F H, and through G and C, M N and O O; make F L equal I L of FIG. 1; make G N and G M equal J N and J M of FIG. 1. Joint C is made at right angles to B C; make C O and C O each equal D O of FIG. 1; make A Z three inches for straight wood; make the joint Z at right angles to B Z; make A E equal A H; draw lines from H and E to joint Z parallel to B Z. Through O M L K E of the convex and O N H of the convex trace the curved edges of the face-mould. The sides of the wreath at joint C are made at right angles to the face of the plank.† The angle with which to square the wreath at joint Z is taken by the bevel C of FIG. 1. Face-mould FIG. 4 is explained in detail at PLATE No. 12. Face-mould FIG. 5 is explained in detail at PLATE No. 10. The development of a centre line of wreath as at FIG. 2 is given in detail at PLATE No. 20, FIGS. 3 and 4.

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* *In face-moulds of this kind, if the drawing is carefully made, instead of the length of this level line,* **Y H** *being applied as a test, it may be used with the length of either one of the tangents to establish the angular point* **H**.

† The sides of wreaths are straight vertically, and can be worked correctly only in that direction with suitable hollows and rounds. After a wreath is shaped, if a straight-edge is tried square across the side of it at any point it will be found hollow on the concave side and rounding on the convex side. For this reason in cases like face-mould FIG. 5, joint **C**—in fact, at centre joints of all face-moulds—should properly have some over-wood at **O O** left on in marking out the stuff.

FIG. 4.

FIG. 2.

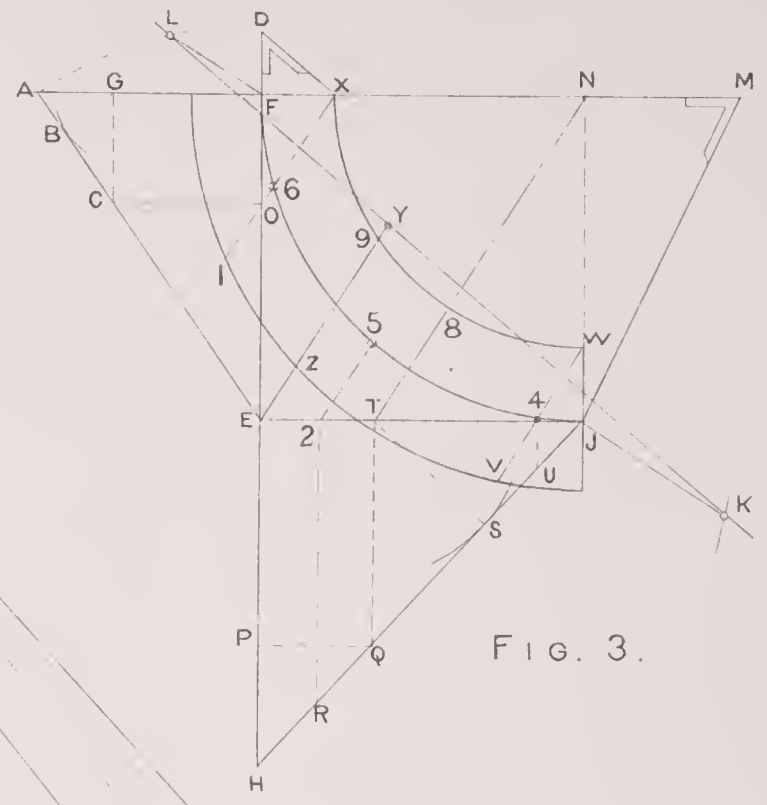
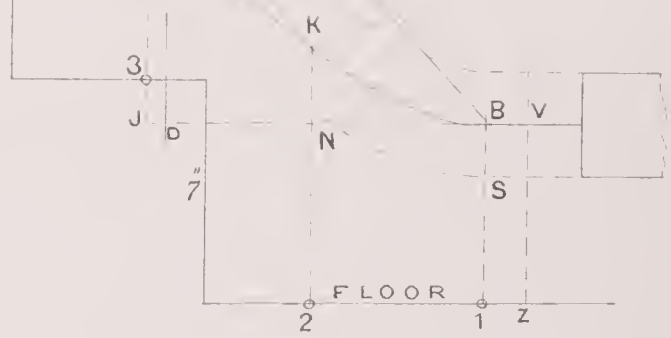


FIG. 3.



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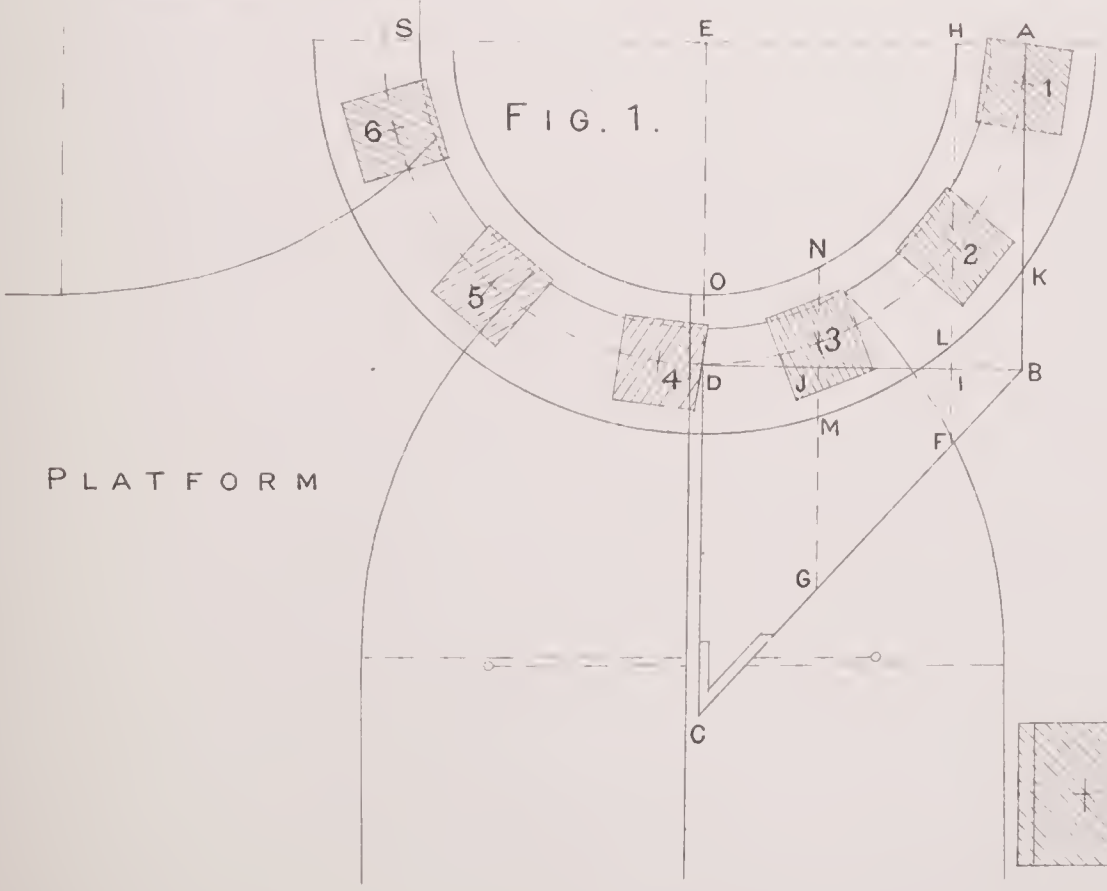
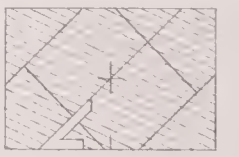


FIG. 1.



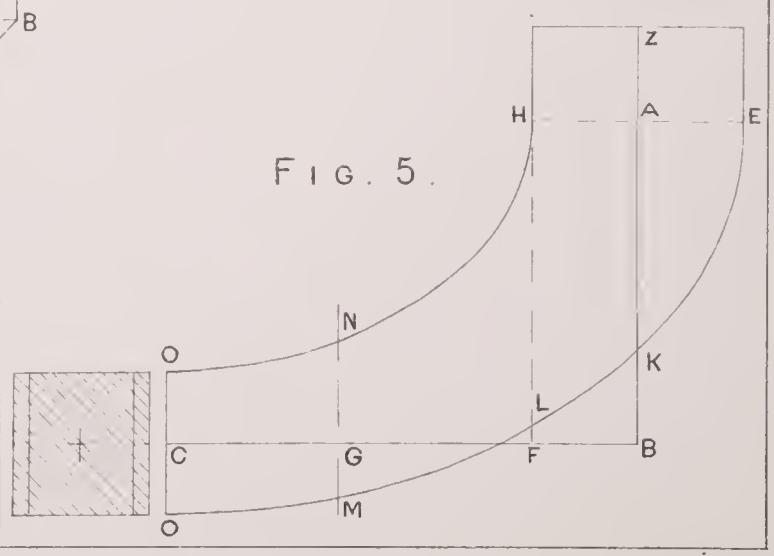


FIG. 5.

PLATE 45.

Fig. 1. Plan of a Circular Flight of Stairs Winding Around a Circular Post.—In planning these stairs the first thing to do is to fix the place of the starting riser. The next consideration is the landing and head-room. In this case the first, or starting, rise becomes the landing and seventeenth rise, making one revolution; the whole height—the rises being 8″—is therefore 11′.4″. In finding the head-room at a point between the starting and landing rises, from the landing deduct 10″ floor-beam, and 2″ for floor and plaster; deduct also the bottom rise, 8″—all together 20″, to be taken from 11′.4″, leaving 9′.8″ head-room. Then, again, the floor at the landing is brought on a line of the fifth rise E B, which makes it necessary to deduct from the last sum four rises,—32″,—leaving a balance of head-room at that point of 7′.0″. The post is sometimes cased as shown. The tread around the line of travel is 7″, about the least that ought to be permitted, if a hand-rail * is put around the post; but if a rail is hung over the outside string, then the line of travel would be further out, and give a tread of $9\frac{1}{2}$″, which would leave the plan as it is, ample. If the staircase is to stand independent of wall or partition, the string should be bent laminated—see PLATE No. 8, FIG. 5—as being stronger than by any other method. To give support to the string it may be enclosed to the floor from A to C, or from A to B, and then set a supporting post at C, and at D suspend the string with a small iron rod from the floor-beam of the story above. If the circular post is made large enough, each riser can be set into mortices in the post four or five inches, and secured with lag-screws; the steps, too, should be let into the post about 2″.

Figs. 2, 3 and 4.—Fig. 2 is a Plan of Stairs such as is given at Plate No. 7, Fig. 8, in which the Cylinder, 5″ Thick, is Best Built Solid and Veneered, Both Faces for a Close String.—The manner of building the solid cylinder is shown by the two thicknesses of staves between the veneers; the straight portion, built with the cylinder from F to N, is so worked for the purpose of including the easement at the lower edge of the concave face FIG. 4.

FIG. 3. *The veneer laid out for the convex face of the cylinder*, the lettering agreeing with that face on the plan FIG. 2. The vertical and irregular lines are to show the position and lengths of staves required for the convex face.

FIG. 4. *The veneer laid out for the concave face of the cylinder*, the lettering agreeing with that face on the plan FIG. 2. The vertical and irregular lines indicate the lengths and position of the staves for the concave face of the cylinder. This veneer is first laid over the prepared, rough-staved cylinder, and on the veneer the concave-faced staves are fitted and glued; then the convex staves are fitted and glued over these again; and, finally, the convex veneer FIG. 3 is glued over the whole.

Fig. 5. Plan of Quarter Platform Stairs, Showing another Way of Placing the Risers Connecting with the Quarter Cylinder.—A riser may be placed at the chord A; then taking A B—which is the tangent to the centre line of rail—and a portion of the other tangent, B D, to equal together one tread, as follows: A B = $6\frac{1}{2}$″, B C = $3\frac{1}{2}$″, making 10″ one tread to the place of the next riser C.

See PLATE No. 5, FIG. 10, *and* PLATE No. 37, FIG. 5.

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* *For treatment of hand-rail over circular stairs see* PLATES 53 *and* 54.

FIG. 1.

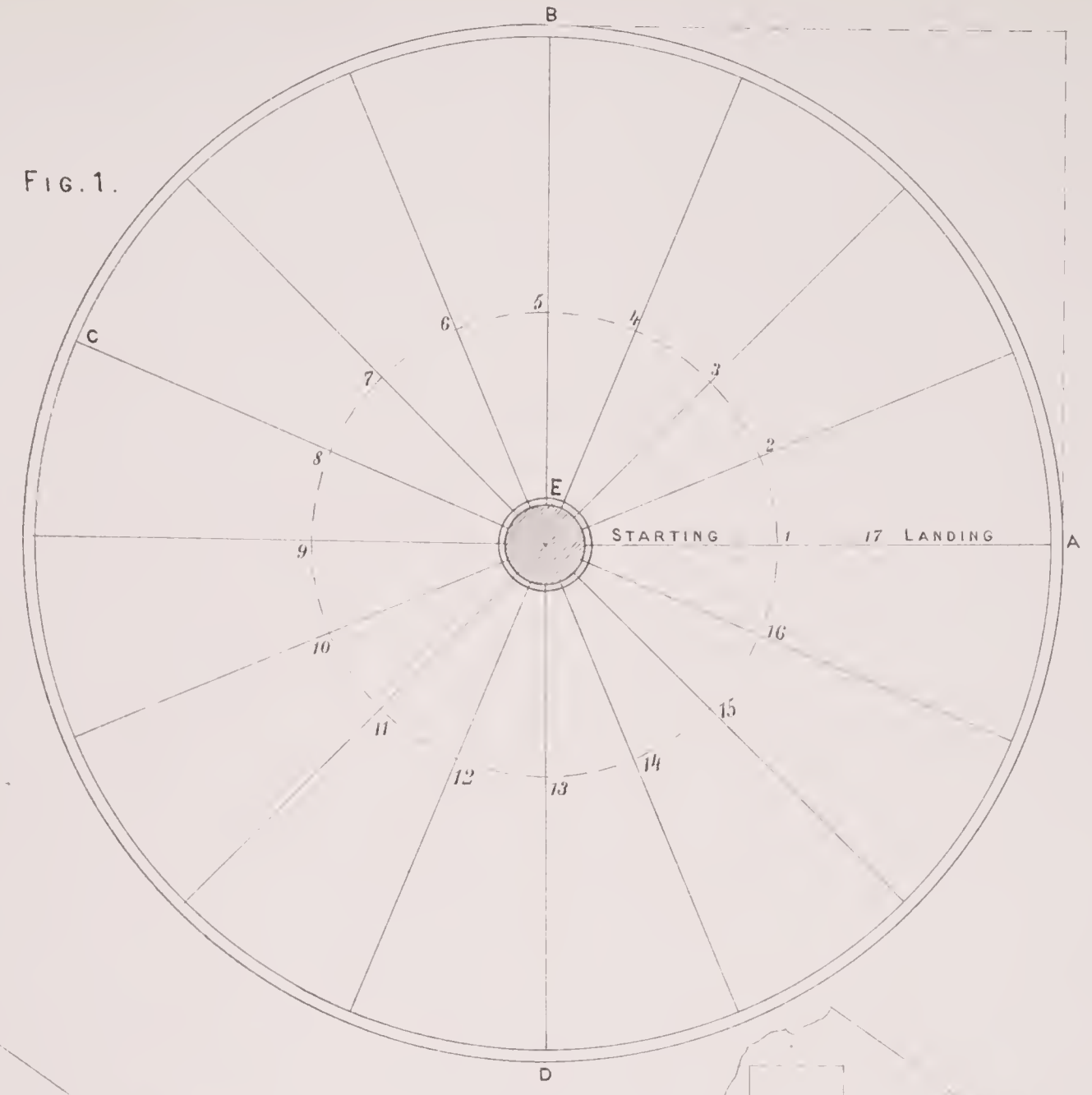


FIG. 3.

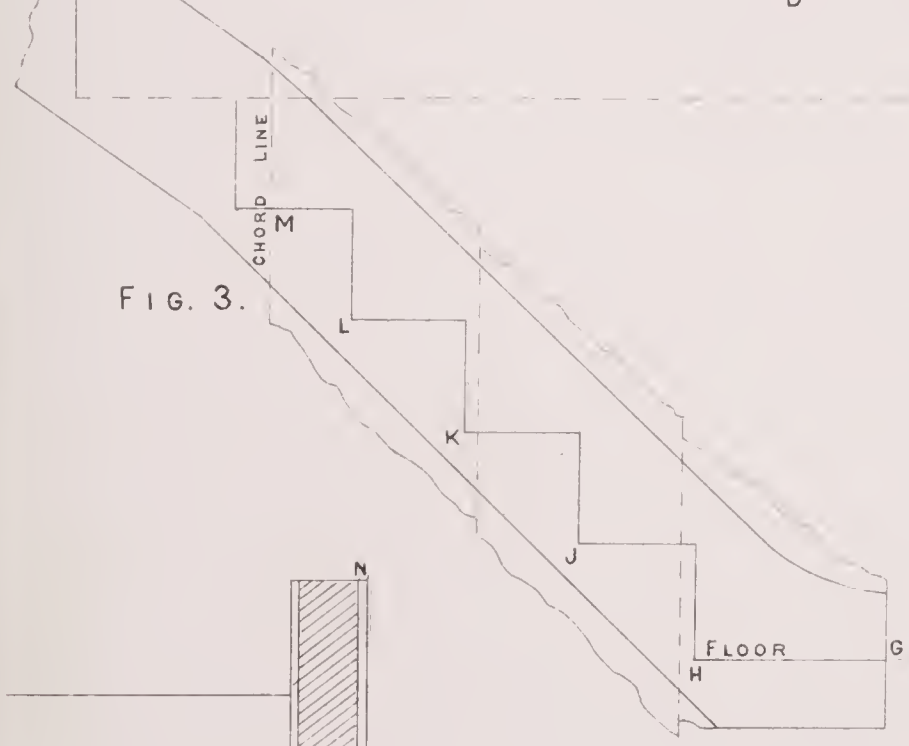


FIG. 4.

FIG. 2.

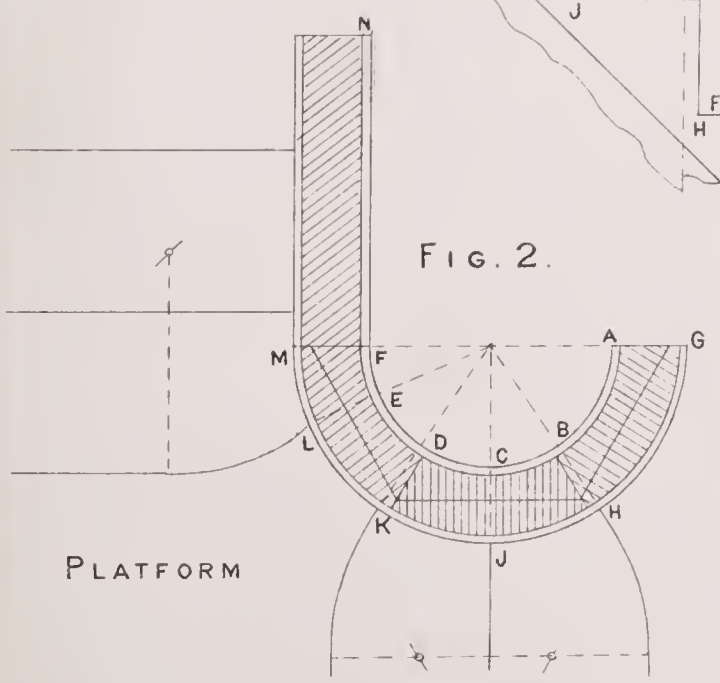
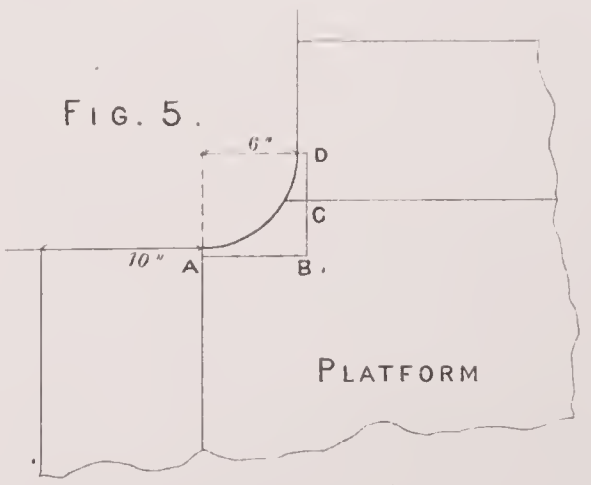


FIG. 5.



SCALE 3/4 IN = 1 FT.

PLATE 46.

Fig. 1. A Superior Plan of Stairs Making a Quarter-turn at the Landing, with Parallel Steps and Platform, in about the Same Space required when Planned with Winders.—This plan is given at PLATE No. 7, FIG. 4. Describe the centre line of rail, and draw the tangents at each quarter cylinder. Space the balusters as required. To find the angles of inclination over the plan tangents, and other measurements, the elevation must first be set up.

Fig. 2. Elevation of Treads and Rises as given at Fig. 1 on the Centre Line of the Hand-rail; also the Development of the Centre Line of Wreath-piece.—Place the chord-lines—of which there are three needed—as at the plan. Put the centres of balusters 1, 2, 3 as given on each tread, and draw lines indefinitely through these centres parallel to the rise-lines. From chord-line A make A B equal A B of FIG. 1. Through B draw B C parallel to the rise-lines; on the line B C—assuming any point C that will raise the wreath a little high rather than fix it low—draw C F, the centre line of ramp, and the inclined line over the first plan tangent; where this line C F intersects the chord-line at A draw A B at right angles to the chord-line; make E Y equal E B of FIG. 1: then Y becomes a fixed point. Make H Z equal P V of FIG. 1; draw Z Q at right angles to H Z; make Z O four inches, and A Q half the thickness of rail: then Q is a fixed point (unalterable if the level rail is to be kept at its usual height). Connect Q Y; divide P D in two equal parts at G; make A F four inches for straight wood to be left at the lower end of the wreath-piece. Again at FIG. 1 make the angle V Q P equal E D Y of FIG. 2; draw T R and W N parallel to U Q; make the angle E D B equal E D Y of FIG. 2; make the angle B C A equal B C A of FIG. 2; make B H equal E D; parallel to B A draw H Z; parallel to C B draw Z G; connect G F, the directing level line; parallel to G F draw 2 M and 1 K; parallel to E D draw M L; parallel to B C draw K J. Again at FIG. 2, baluster 1, make K J equal K J of FIG. 1; at baluster 2 make M L equal M L of FIG. 1; through the points D L J A trace the centre line of wreath-piece; set off half the thickness of rail each side of the centre, as shown by the dotted lines.

To Find the Length of Balusters:—Take for example baluster 2: 2 N equals $3\frac{1}{2}''$, which added to $2'.2''$, the usual length of short baluster at X (between the top of step and the bottom of rail), makes the length of baluster 2 between the same points $2'.5\frac{1}{2}''$.

Fig. 3. Face-mould from Plan of Rail at the Landing Quarter-circle Fig. 1: also Showing the Squaring of the Piece at the Joints.—Draw the lines G Q and Q J at right angles; make Q R N P equal Q R N P of FIG. 1; make P G equal P G of FIG. 2; make Q U equal V U of FIG. 1; make U J equal $2''$ for straight wood; make joint G parallel to J Q; make T K and joint J parallel to Q G; parallel to J Q draw I T, N W and X P X; make P X and P X each equal P X of FIG. 1; make R I and Q Y equal S I and V Y of FIG. 1; draw lines from X and X to joint G parallel to P G; make U K equal U T; from K and T draw lines to joint J parallel to J Q; through K V I X of the convex and T W X of the concave trace the curved edges of the face-mould. The angle with which to square the wreath at joint J is taken by the bevel Q of FIG. 1. The sides of wreath-piece at joint G are made at right angles to the face of the plank, and the over-wood is removed equally from both faces of the plank. The dotted lines show the increased width of stuff required to work out the wreath-piece of a hand-rail of so much greater depth than width.

Fig. 4. Plan of Hand-rail, Quarter-circle A E of Fig. 1, with its Angles of Inclination E D B and B C A.—Let B H equal E D; make H Z parallel to B A, and Z G parallel to C B; connect G F, the directing level line; parallel to G F draw V S, B 5 and R I; at right angles to G F draw A P and E W, each indefinitely; on B as centre with B D as radius describe the arc D W; again on B as centre with C A as radius describe an arc at P; connect P W.

To Find the Angle with which to Square the Wreath-piece at the Joint over E:—Prolong B E to T; make E T equal E M; connect T 5: then the bevel at T will contain the angle required.

To Find the Angle with which to Square the Wreath-piece at the Joint over A:—Prolong E F to U; make F U equal G N; connect U A: then the bevel at U will contain the angle sought.

Fig. 5. Face-mould from Plan of Hand-rail Fig. 4; also Showing the Squaring of the Wreath-piece at the Joints.—Draw the line A D indefinitely; make X D and X A equal X W and X P of FIG. 4. On A as centre with A C of FIG. 4 as radius describe an arc at B; on X as centre with the level line X B of FIG. 4 as radius intersect the arc at B; connect A B, D B and X B; prolong B D to G, and B A to F; make A F equal A F of FIG. 2; make D G equal D G of FIG. 2; make the joints G and F at right angles to the tangents; make D K equal D K of FIG. 4; make B Z 4 equal C Z 4 of FIG. 4; through K Z 4 parallel to B X draw S V, L J and I R indefinitely; make K V, K S equal Q S, Q V of FIG. 4; make B O, X O equal the same at FIG. 4; make Z L and Z J, 4, I and 4 R equal G J and G L, Y I and Y R of FIG. 4; through D draw V C; make D C equal D V; through A draw R H; make A H equal A R; from R and H draw lines to joint F parallel to B F; from V and C draw lines to joint G parallel to B G; through C S O L I H of the convex and V O J R of the concave trace the curved edges of the face-mould. Four additional points on the centre line may be measured as shown, and a parallel pattern made by describing arcs of circles of a radius to suit the width given by the squaring of the joints; or the extra width may be scribed on the plank from the edges of the face-mould. The slide-line is drawn at right angles to the directing level line B X. The angle used for squaring the joint G is taken from T of FIG. 4, and for squaring the joint F the angle at the bevel U of FIG. 4. *For detailed explanation of face-mould* FIG. 3 *see* PLATE No. 10, *and for face-mould* FIG. 5 *see* PLATE No. 12.

PLATFORM

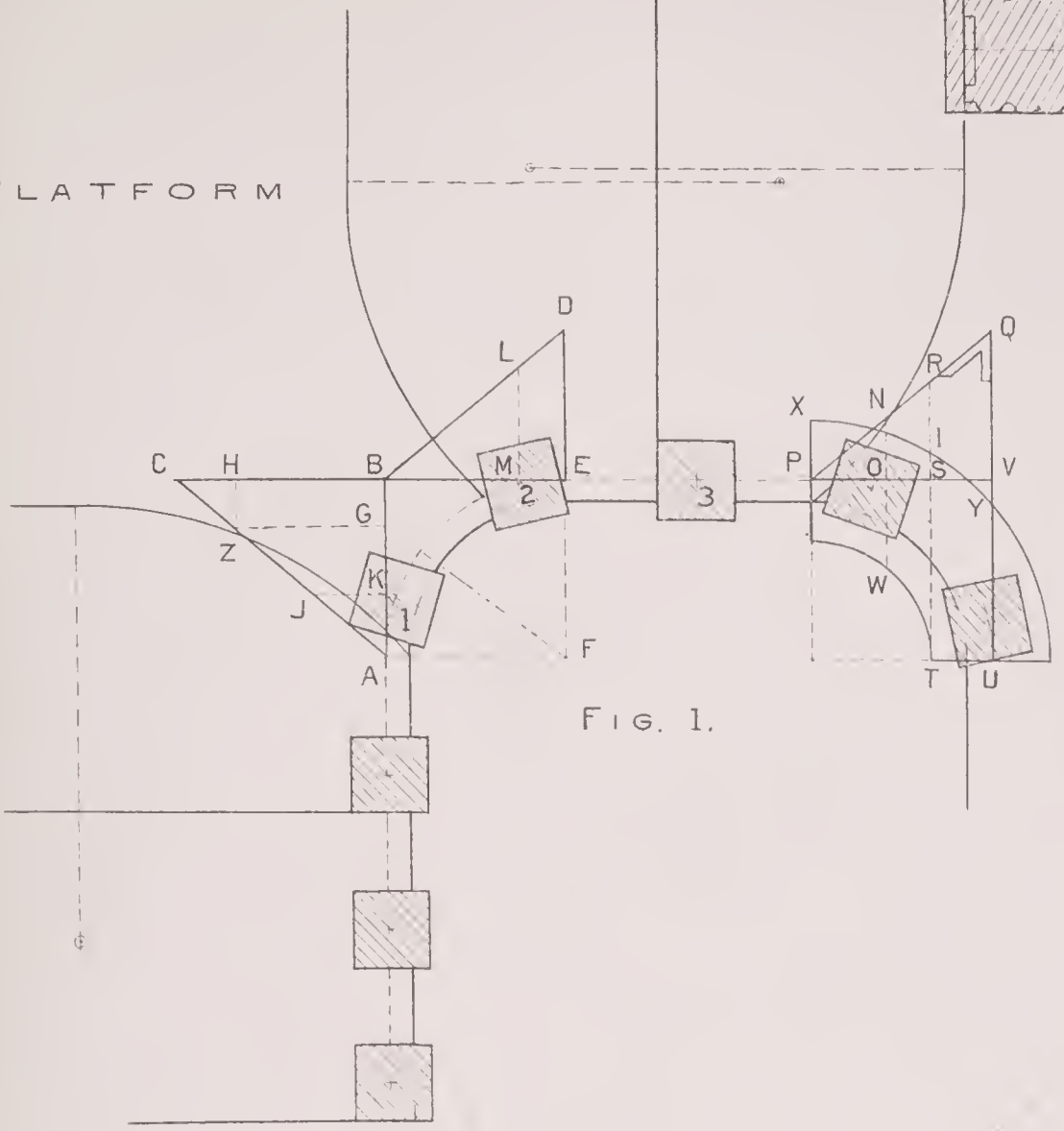


FIG. 1.

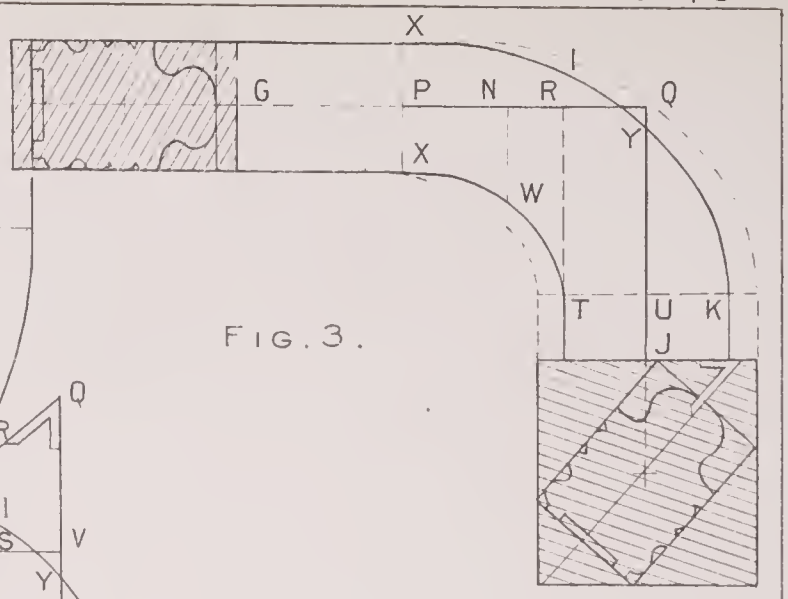


FIG. 3.

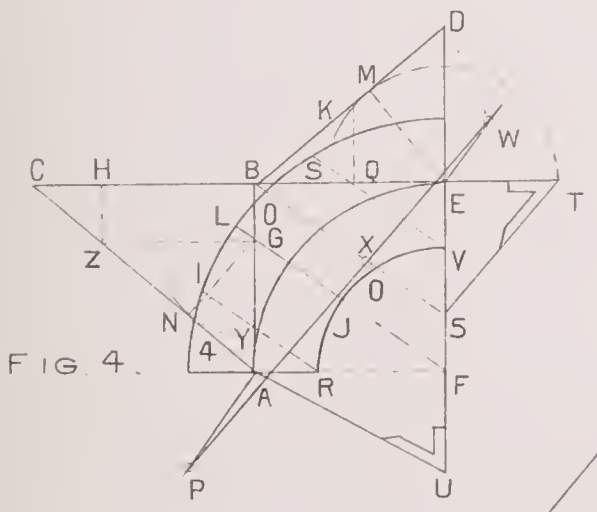


FIG. 4.

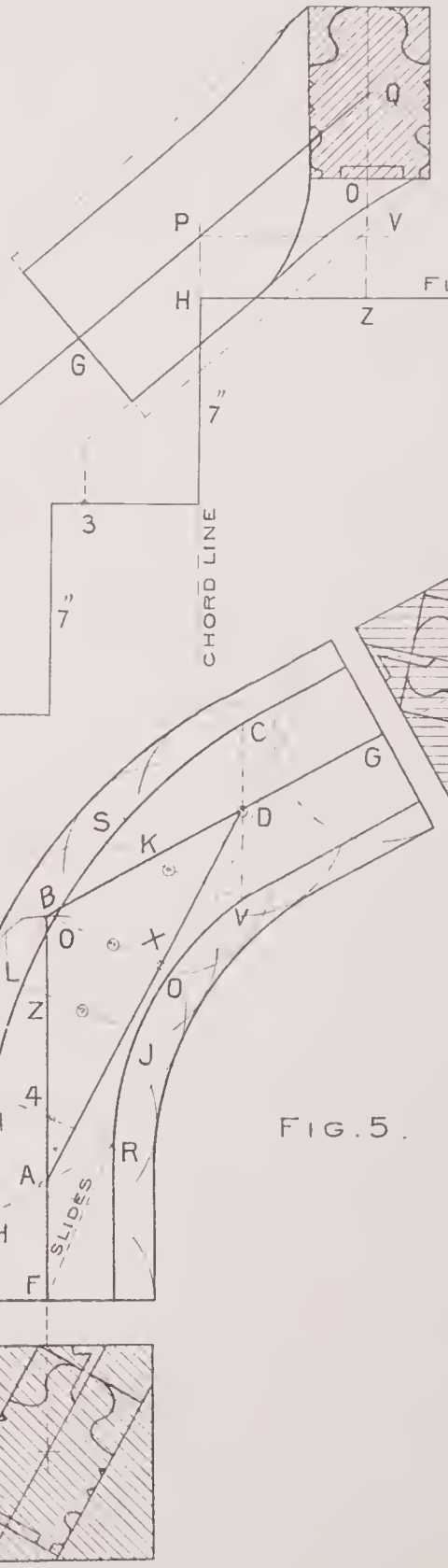


FIG. 2.

FIG. 5.

SCALE 1½ IN. = 1 FT.

PLATE 47.

Fig. 1. Plan of a Part of a Flight of Winding Stairs of which this Portion makes a Half-turn.—This plan is given complete at PLATE No. 7, FIG. 3. Draw the centre line of rail and the tangents. Space the balusters as required; then to find angles, measurements, etc., proceed to set up the elevation.

Fig. 2. Elevation of Treads and Rises as given at Plan Fig. 1; also the Development of the Centre Line of the Wreath.—Place the chord-lines—of which there are two, A and G—as given at the plan, and extend the upper one, J D, at an indefinite length. Put the centres of the balusters on each step as at the plan, and draw lines through these parallel to the rise-lines indefinitely. With a straight-edge held in the direction A J mark a point at the lower chord, A, and at the upper chord, J; with the understanding that if J is placed lower on the chord-line, then the upper ramp will be lengthened and the wreath brought lower; and if A is raised higher on the chord-line, then the lower ramp, already about right, would be increased in length and curve. So at pleasure fix A and J; then draw A D at right angles to the chord-line; divide D J in four equal parts; make A B equal the tangent A B of FIG. 1; draw B C parallel to the rise; make B C equal D E; connect C A, and prolong to N indefinitely. At right angles to J F draw G H; let G H equal G H of FIG. 1; connect H J, and prolong to O indefinitely; make J O and A N each 3″ for straight wood at those ends of the wreath-pieces. Make the joints of ramps at N and O at right angles to N C and H O. Again at FIG. 1, as the four heights to be raised at each tangent are alike, make all the angles of inclination B C A, E F B, H K E and G H J equal B C A of FIG. 2. Draw the directing level lines M B and M H; parallel to M B draw 1 R and 2 S; parallel to B C draw R L; parallel to E F draw S T. Again at FIG. 2, baluster 1, make R L equal R L of FIG. 1; at baluster 2, make 2 T equal S T of FIG. 1; at baluster 3, P K equals H K of FIG. 1. Through A L T K J trace the centre line of the wreath. Set off each side of the centre half the thickness of rail as shown by the dotted lines.

To Find the Lengths of Balusters:—Take for example baluster 1: 1 R measures $1\frac{1}{8}''$, which added to $2'.2''$—the usual length of balusters at X X between the top of step and bottom of rail—makes the length of baluster 1 between the same points $2'.3\frac{1}{8}''$.

Fig. 3. Plan of Hand-rail, Quarter-circle A E, Fig. 1, with its Tangents and Angles of Inclination Lettered Alike.—Connect M B, the directing level line. Parallel to M B draw Q P; parallel to E F draw O N; through E draw A U indefinitely; on B as centre with B F as radius describe the arc F U.

To Find the Angle with which to Square the Wreath-piece at Both Joints:—Prolong B E to T; make E T equal E Y; connect T M: then the bevel at T will contain the angle required.

Fig. 4. Face-mould from Plan Fig. 3, also Showing the Squaring of the Wreath-piece at Both Joints.—Draw the line U U indefinitely; make V U, V U equal V U of FIG. 3. Draw V B at right angles to U V; make V B equal V B of FIG. 3; connect B U and B U; prolong B U to W, making U W equal A N of FIG. 2. The joints U and W are made at right angles to the tangents. Make B N and B N each equal B N of FIG. 3. Through N and N parallel to B Z draw P R and P R; make N R and N R each equal O Q of FIG. 3; make N P and N P each equal O P of FIG. 3; make V Z equal V Z of FIG. 3. Through U and U draw R S and R S, and make U S equal U R at U and U; draw R Y parallel to B U; from S and R draw lines to joint W parallel to B W; through S P B P S of the convex and R Z R of the concave trace the curved edges of the face-mould. *The angle with which to square the wreath-piece at both joints is taken by the bevel* T *of* FIG. 3. For detailed explanation of this face mould see PLATE No. 11. The development of the centre line of a wreath-piece of this kind is given in detail at PLATE No. 20, quarter-circle A C of FIG. 1, and AE of FIG. 2.

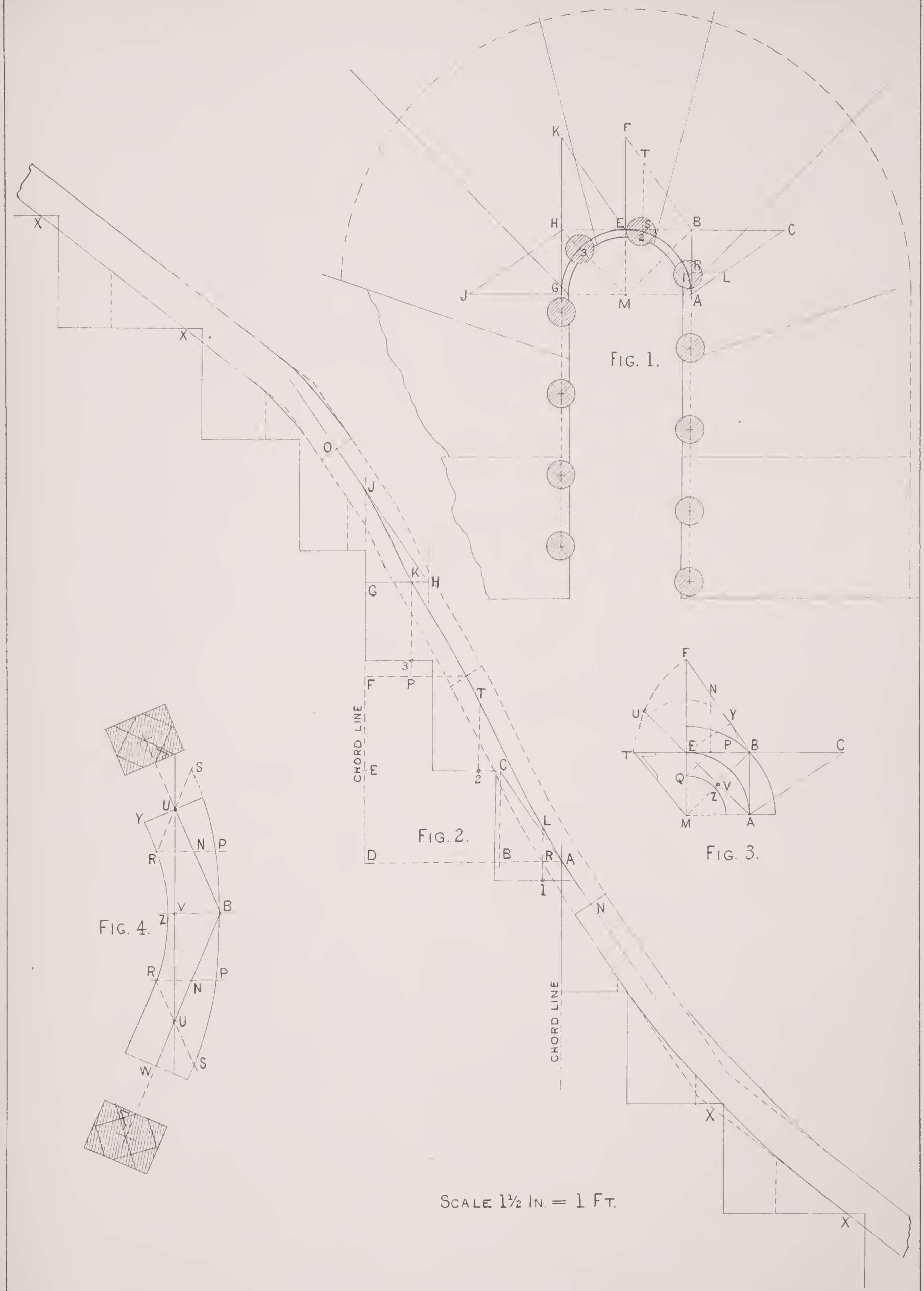


FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

SCALE 1½ IN. = 1 FT.

PLATE 48.

Fig. 1. Plan of the Bottom Part of a Flight of Winding Stairs, Turning One Quarter, Starting with a Newel.—The complete plan of this flight of stairs is given at PLATE No. 7, FIG. 3. Draw the centre line of rail, and space the balusters as required; then to find the length of plan tangent A C, and other measurements, proceed to set up the elevation.

Fig. 2. Elevation of Treads and Rises as Given at Plan; also the Development of the Centre Line of the Wreath-piece.—Place the centre of baluster on each step as at the plan, and draw lines through these centres parallel to the rise-lines indefinitely. Let the bottom line of rail pass through X X, the centres of short balusters on the regular treads; draw the centre line of rail O C parallel to X X indefinitely; make B O equal $2\frac{1}{2}''$—or more at pleasure—for straight wood at the upper end of the wreath-piece; make M V, $6''$ and V N half the thickness of rail; through N at right angles to the chord-line draw A C: then A C will be the length of the plan tangent A C at FIG. 1. And if from C of FIG. 1 a line is drawn touching the centre line of rail at M, it will be the level tangent.

Fig. 3. Plan of the Centre Line of Rail and Tangents A C and C M from Fig. 1; also the Centres of Balusters D, G, J in Place as at Fig. 1.—Through A draw T B at right angles to A C; make A B equal A B of FIG. 2; connect B C. T is the centre of the circle, and T M is at right angles to C M as at FIG. 1. Through the centres of balusters J, G, D, and parallel to the level tangent M C, draw J K, V H and S E; parallel to A B draw E F, H I and K L; from A draw A P at right angles to the level tangent C M; on C as centre with C B as radius describe the arc B P; connect P M.

To Find the Angle with which to Square the Wreath-piece at the Joint over A:—From E parallel to C B draw E R indefinitely; prolong C A to Q; make A Q equal A R; connect Q S. Then the bevel at Q contains the angle required.

To Find the Angle with which to Square the Wreath-piece at the Joint over M:—Make U V equal H I; connect V M. Then the bevel at V contains the angle sought. Again at FIG. 2, baluster D, make E F equal E F of FIG. 3; at baluster G, make H I equal H I of FIG. 3; at baluster J, make K L equal K L of FIG. 3. Through the points B F I L N trace the centre line of the wreath-piece; set off each side of the centre half the thickness of rail as shown by the dotted lines.

To Find the Lengths of Balusters:—Take for example baluster D; D S measuring $4\frac{1}{2}''$, which must be added to $2'.2''$—the length of short baluster at X from the top of step to the bottom of the rail—making the length of the baluster D between the same points $2'.6\frac{1}{2}''$. The height of rail at the newel is calculated by adding M V, $6''$ to the length of short baluster at X, $2'.2''$; making the height from M to V $2'.8''$.

Fig. 4. Parallel Pattern for Wreath-piece from Plan Fig. 3; also Showing the Squaring of the Wreath-piece at the Joints.—Make M B equal M P of FIG. 3. On B as centre with B C of FIG. 3 as radius describe an arc at C; on M as centre with M C of FIG. 3 as radius intersect the arc at C; connect C M and C B; prolong C B to O; make B O equal B O of FIG. 2. Make M W equal M W of FIG. 1. Make the joints O and W at right angles to the tangents. Make B F I L equal to B F I L of FIG. 3. Make F D, I G and L J equal E D, H G and K J of FIG. 3. On the centres B D G J M with a radius equal to half the required width of the pattern describe circles, and touching these trace the edges of the pattern. The angle with which to square the wreath-piece at joint O is taken by the bevel Q of FIG. 3, and the angle for squaring the wreath-piece at joint W is taken by the bevel at V of FIG. 3. The development of a centre line geometrically the same as this of FIG. 2 is given at PLATE No. 21, FIGS. 1 and 2. Face-mould and parallel pattern as required by this plan are treated geometrically in detail at PLATE No. 14.

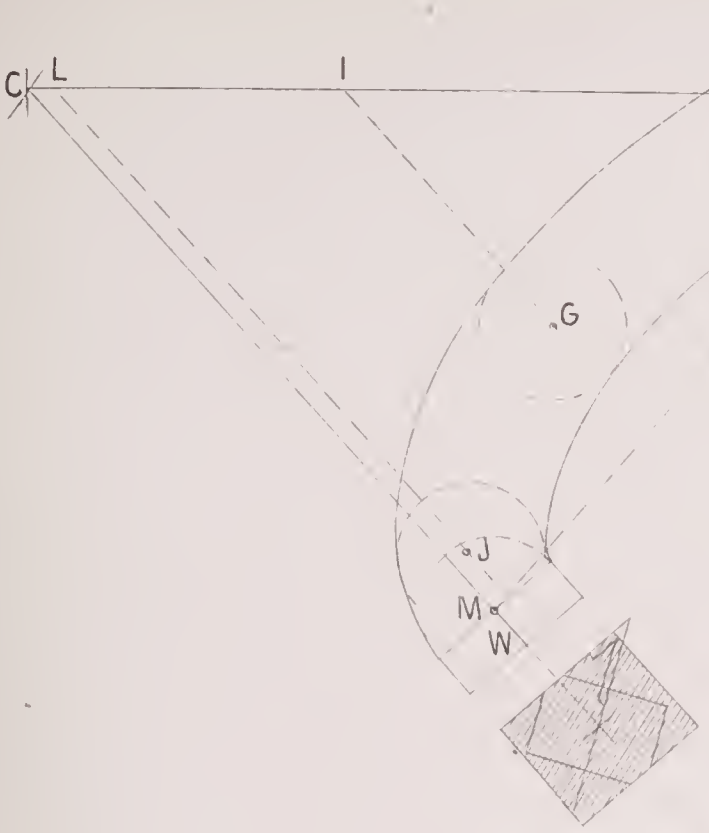


FIG. 4.

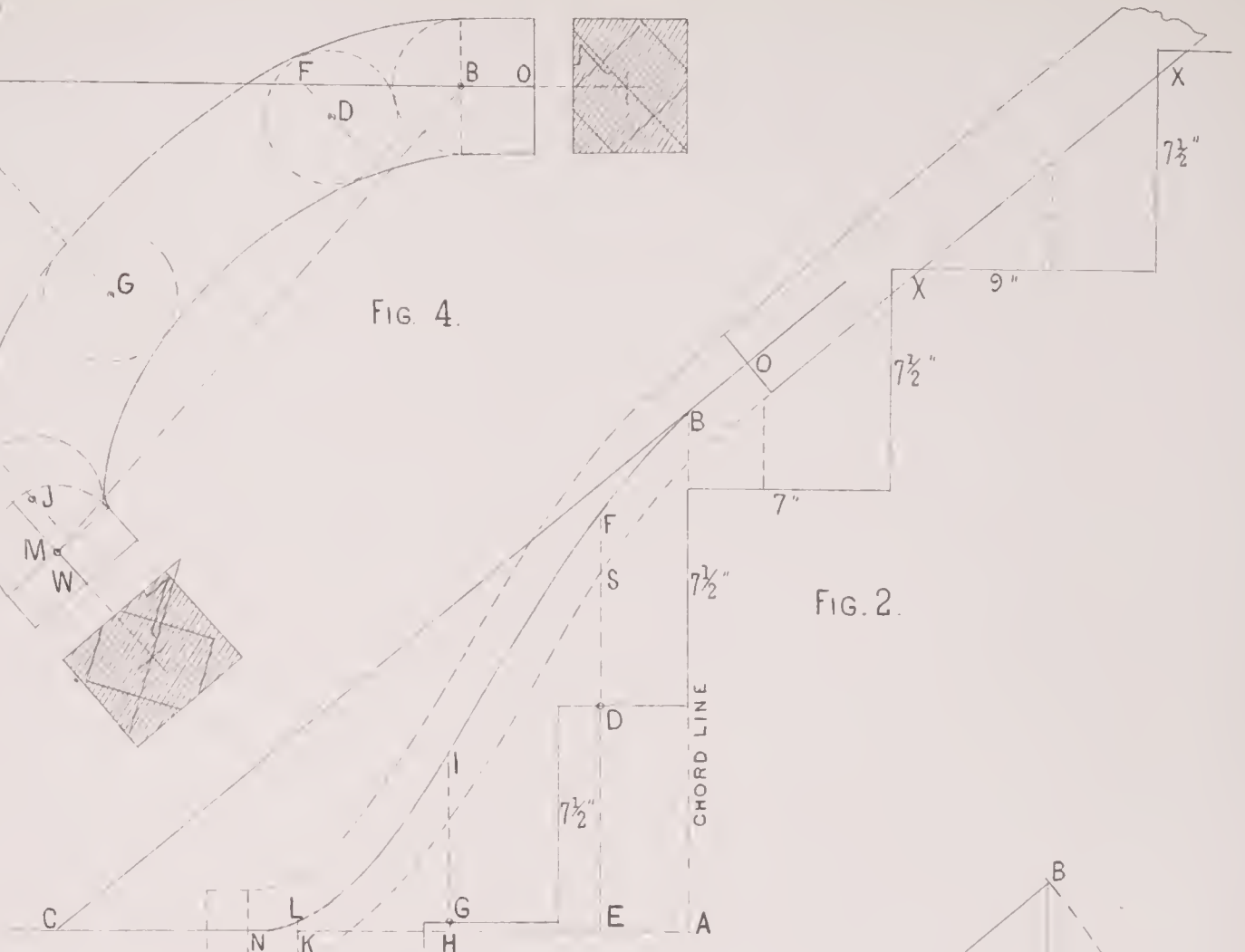


FIG. 2.

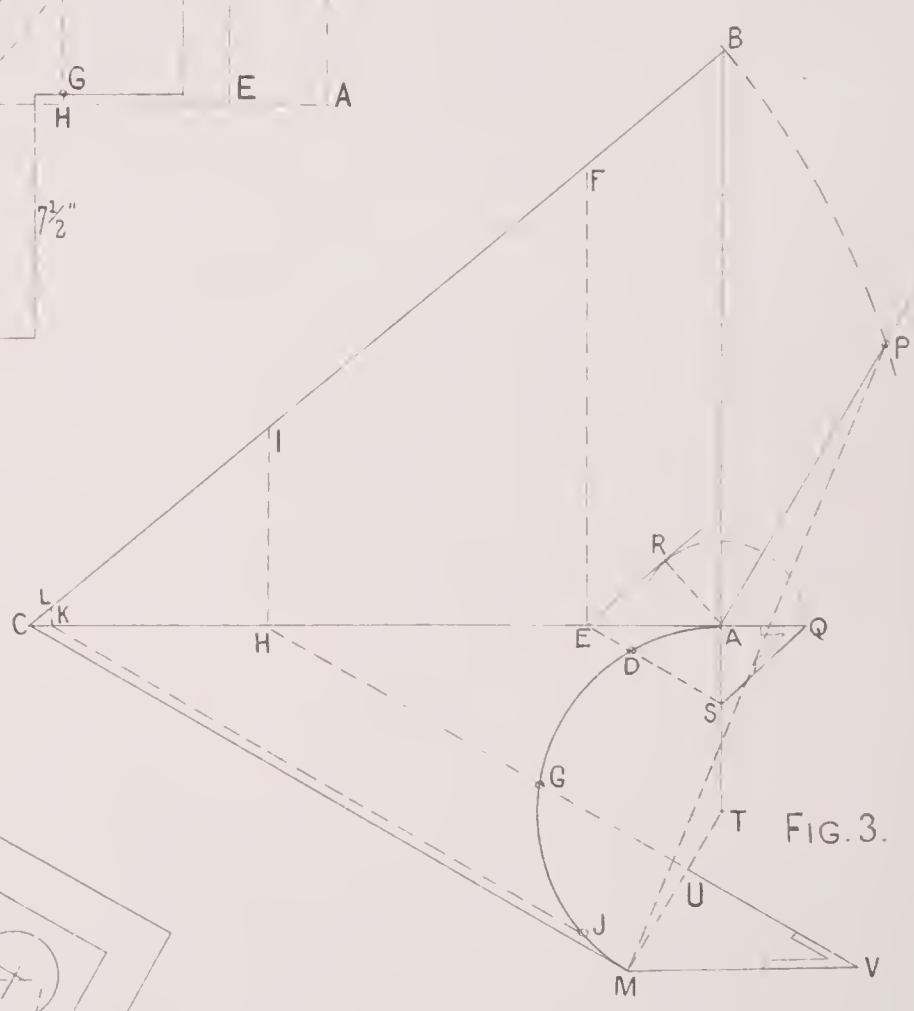


FIG. 3.

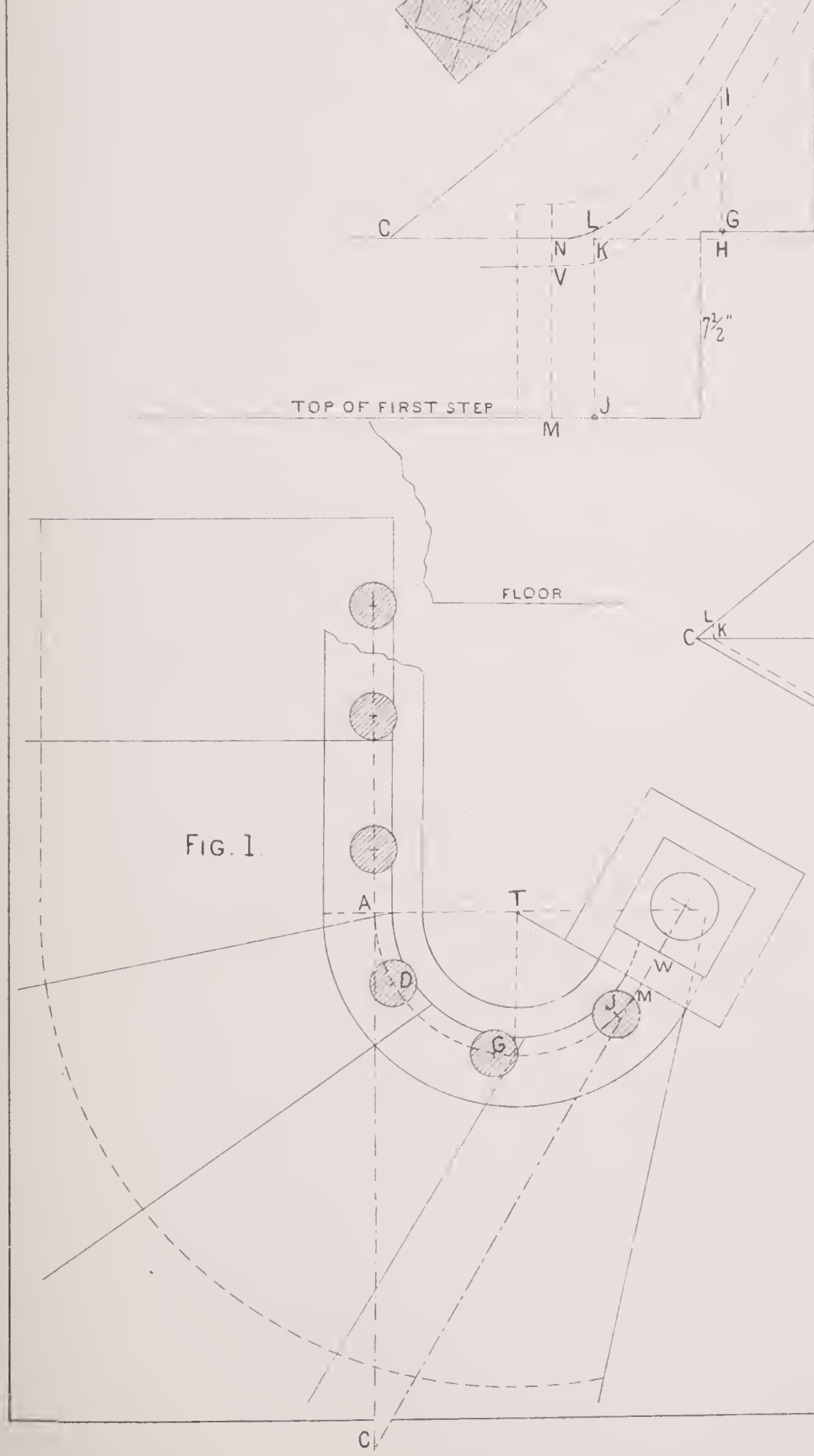


FIG. 1.

SCALE 1½ IN. = 1 FT.

PLATE 49.

Fig. 1. Plan of the Bottom Portion of a Flight of Winding Stairs, this Part of the Flight Turning a little more than a Quarter and Starting from a Newel.—This case of hand-railing is geometrically the same as that given at PLATE No. 48. In the last-mentioned Plate the cylinder is 10″ in diameter, embracing three winders; but the plan here presented has a cylinder 20″ in diameter, containing five winders. The object of introducing this example is to demonstrate the correctness and practicability of working the wreath around a large cylinder in one piece, showing, too, by the development of the centre line of the wreath its exact position and relation to step and rise. The length of plan tangent A B cannot be determined until the elevation is drawn, if a fixed height of rail at the newel is required.

Fig. 2. Elevation of Treads and Rises as at Plan; also the Development of the Centre Line of Wreath-piece.—Let the bottom line of rail pass through X X, the centres of short balusters on the regular treads; draw the centre line of rail F B parallel to X X indefinitely; make 1 E equal 8″, and E G half the thickness of rail. Through G draw B A at right angles to the chord-line. Again, at FIG. 1, continue the centre line of rail to B, and make A B equal A B of FIG. 2; make A C at right angles to A B and equal to A C of FIG. 2; from B draw B Z tangent to the centre line of rail; from H, the centre of the cylinder, draw H O at right angles to B Z; then B O is the level tangent. Place the balusters as required, and number those that come under the wreath. Through balusters 2, 3, 4 and 5 draw S 8, F 7, I, 6, 5 T, and from P, P R, all parallel to O B; parallel to A C draw T K, Q L, 6 N, 7 J and 8, 9.

To Find the Angle with which to Square the Wreath-piece at the Joint over Z:—Make G F equal 7 J; connect F O: then the bevel at F contains the angle required.

To Find the Angle with which to Square the Wreath-piece at the Joint over A:—From N draw N M parallel to A B; make A E equal M K; connect E I: then the bevel at E contains the angle sought. From A draw A D indefinitely and at right angles to B O; on B as centre with B C as radius describe the arc C D; connect D O. Again, at FIG. 2, place the centres of balusters on each step as at the plan, and draw lines through these centres parallel to the rise-lines. At baluster 2, make 8, 9 equal 8, 9 of FIG. 1; at baluster 3, make 7 J equal 7 J of FIG. 1; at baluster 4, make 6 N equal 6 N of FIG. 1; at baluster 5, make T K equal T K of FIG. 1; through C K N J 9 G trace the centre line of the wreath-piece; from this centre set off each side half the thickness of rail as shown by the dotted lines. Proceed to find the lengths of balusters and the height of rail at newel as directed at PLATE No. 48.

Fig. 3. Face-mould from Plan Fig. 1; also Showing the Squaring of the Wreath-piece at the Joints.—Draw the line C O equal to D O of FIG. 1; on O as centre with O B of FIG. 1 as radius describe an arc at B; on C as centre with C B of FIG. 1 as radius intersect the arc at B; connect O B and B C; prolong B O to Z; make O Z equal O Z of FIG. 1; prolong B C to F; make C F equal C F of FIG. 2; make the joints Z and F at right angles to the tangents; make C L N J 9 equal the same at FIG. 1; and through each of these divisions draw lines parallel to B O; make O X equal O X of FIG. 1; make J W Y equal 7 W Y of FIG. 1; make N V U equal 6 V U of FIG. 1; make L P, L R equal Q P, Q R of FIG. 1. Through C draw P E; make C E equal C P; make O K equal O S; draw lines from P and E to the joint F parallel to C B; draw lines from K and S to joint Z parallel to B O; through E R V W X K of the convex and P U Y S of the concave trace the curved edges of the face-mould. Joint Z of the wreath-piece is squared by the angle contained in bevel F of FIG. 1, and joint F is squared by the angle contained in bevel E of FIG. 1.

Fig. 4. A Sketch of this Wreath-piece as it Appears when Squared up.

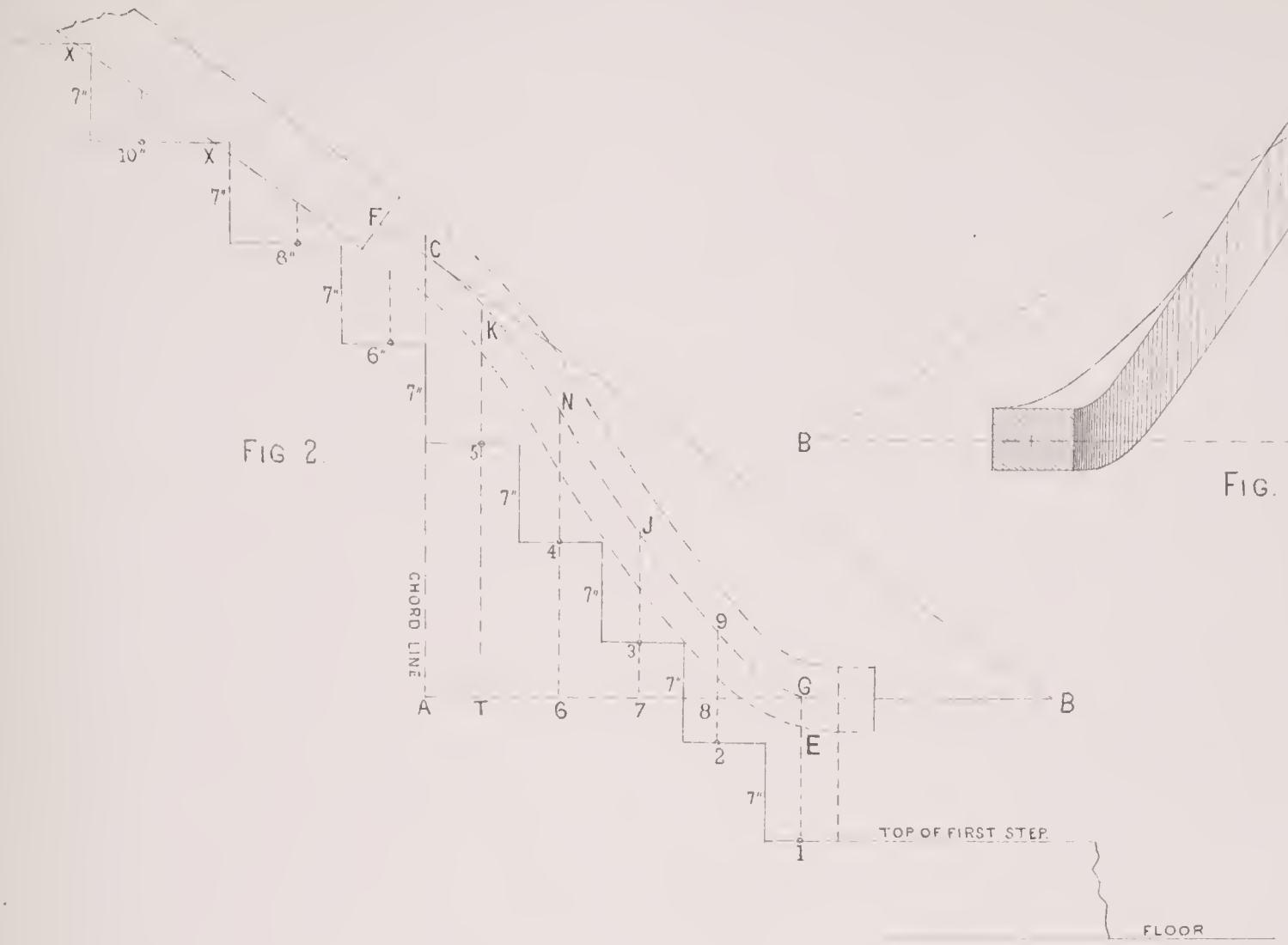


FIG 2.

FIG. 4.

SCALE ¾ IN. = 1 FT.

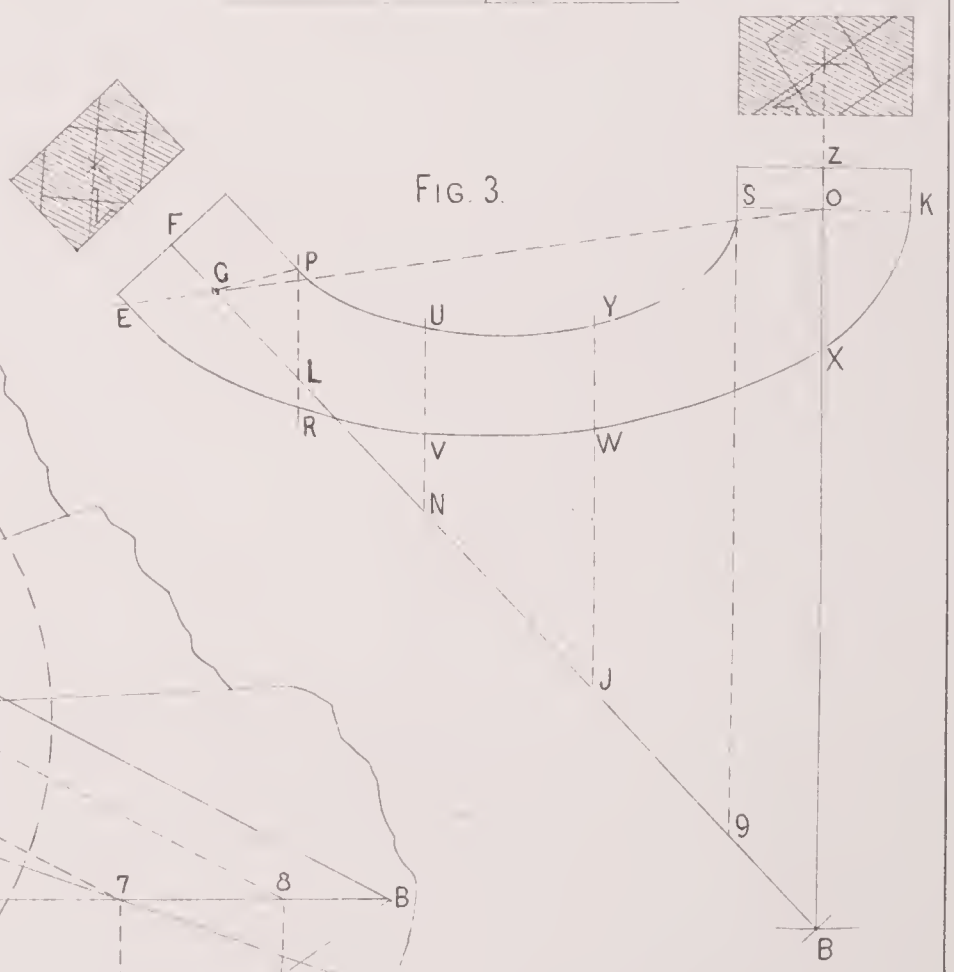


FIG. 3.

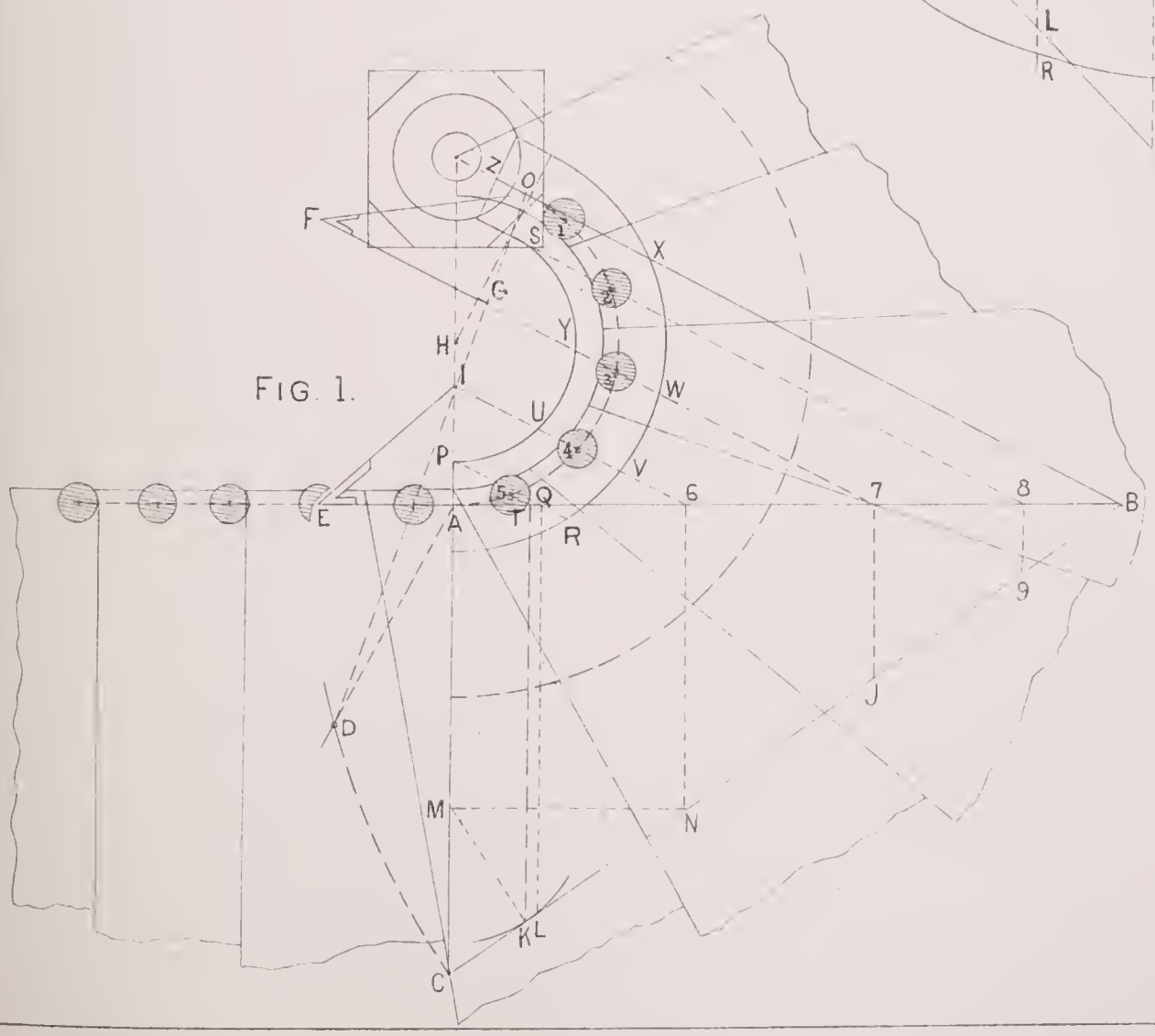


FIG. 1.

PLATE 50.

Hand-rail over Steamboat Stairs, from Plan given at Plate No. 6, Fig. 9.—Figs. 1, 2 and 3 are together the plan of the string with its different curves, including the whole number of treads. Describe the centre line of rail and on this centre line place the balusters on each step numbered as shown. The intention is to take two treads in the first piece of rail from A to C, and in the second piece of rail to include six treads from C to N; the third piece of rail to take the two last treads with as much more as it requires to bring this top wreath-piece to a level at the required height. Draw the level tangent A B at right angles to A J; through C draw B K at right angles to J D; through N at right angles to N, 4, 3 draw K O indefinitely; the point O must now be established by measurement taken from the elevation.

Fig. 4. Elevation of Treads and Rises as given at Plan; also the Development of the Centre Line of Wreath, including the Whole Flight.—On the line of the third rise C D fix D distant from baluster 3, so that the bottom line of rail will pass through 3; draw D K at right angles to D C; make D K equal C K of Fig. 2; draw K L parallel to the rise-lines, and equal to three rises; connect L D, and prolong to B indefinitely; make C B equal C B of Fig. 1 where the length of tangent C B intersects the inclined line D B at B; draw C A through B at right angles to C D; touching L draw G N at right angles to L K; prolong the ninth rise to M and N; make N G equal N K of Fig. 2; make N M equal three rises; connect M G; draw M O at right angles to M N; make 40, 41 equal four inches; make 41, P equal half the thickness of rail. Again at Figs. 1, 2 and 3, make N M of Fig. 2 at right angles to K N, and equal to three rises; then at Fig. 3 make O P equal O P of Fig. 4; draw P, 39 parallel to O N; from N parallel to K M draw N P; from P draw P O parallel to M N; from O draw the line O T, touching the centre line of rail; from the centre V draw V S at right angles to O T: then O S will be the level tangent; parallel to O S draw 12, 36; 11, 34 and Z 10, 33; parallel to O P draw 36, 37; 34, 35; 33, R and 9, 38.

To Find the Angle with which to Square the Wreath-piece from Fig. 3 over Joint N:—Make N, 42 equal 33, 32; connect 42, Z: then the bevel at 42 contains the angle required.

To Find the Angle with which to Square the Wreath-piece from Fig. 3 at the Joint over S:—From R draw R 13 parallel to N O; make S T equal 13, P; connect T U: then the bevel at T contains the angle sought. From N at right angles to S O draw N X indefinitely; on O as centre with N P as radius describe an arc at X; connect X S. At Fig. 2 make K L at right angles to C K and equal to three rises; connect L C; parallel to C L draw B D of Fig. 1; from C through N draw C Q indefinitely; on K as centre with K M as radius describe the arc M Q; connect K, 43; parallel to K W draw 8, 27; 7, 25; 6, 23; 5, 21 and 4, 19; parallel to N M draw 27, 28; 25, 26 and 23, 24; parallel to K L draw 21, 22; 19, 20 and 3, 18.

To Find the Angle with which to Square the Wreath-piece from Plan Fig. 2 at Both Joints:—Draw 28, 29 parallel to K N; make N, 31 equal 29, 30; connect 31, Y: then the bevel at 31 contains the angle required. At Fig. 1, parallel to A B, draw 1, 16 and 2, 14; parallel to C D draw 14, 15 and 16, 17; from C draw C E at right angles to A B; on B as centre with B D as radius describe the arc D E; connect E A.

To Find the Angle with which to Square the Wreath-piece from Plan Fig. 1 at the Joint over C:—Prolong line of joint C D, and level line A B, to G; make C F equal C, 15; connect F G: then the bevel at F contains the angle required.

To Find the Angle with which to Square the Wreath-piece from Plan Fig. 1 at the Joint over A:—Parallel to B A draw C I; make H I equal C D; connect I A: then the bevel at I contains the angle sought. Again at Fig. 4: take all the heights from the plan tangents of Figs. 1, 2 and 3, and place them on the lines drawn through the centres of like-numbered balusters, and as shown by the other corresponding numbers and letters; and through these top-numbers and letters trace the centre line of wreath. The governing length of baluster on this flight ought to be 2′.4″ at its centre, from top of step to bottom of rail. The odd lengths of balusters will be found as before explained. In case the bottom line of rail falls below the step or floor-line, at the centre line of baluster—as, for instance, here at baluster 11—then that distance must be subtracted from the length of the governing baluster; the remainder will be the length of baluster 11.

Fig. 5. Parallel Pattern from Fig. 3 for Wreath-piece, Joining Level Rail at Top; also Showing the Squaring of the Wreath-piece at the Joints.—Make S N equal S X of Fig. 3; on N as centre with N P of Fig. 3 as radius describe an arc at P; on S as centre with S O of Fig. 3 as radius intersect the arc at P; connect S P and P N; make N 38, R 35, 37 equal the same at Fig. 3; make 37, 12 equal 36, 12 of Fig. 3; make 35, 11 equal 34, 11 of Fig. 3; make R 10 equal 33, 10 of Fig. 3; make the joints N and S at right angles to the tangents. Through N, 38, 10, 11, 12 and S as centres, with a radius equal to half the width of the required pattern, describe circles, and touching these trace the edges of the pattern. To square the wreath-piece at joint N take the bevel 42, and for squaring the wreath-piece at joint S take the bevel T.

Fig. 6. Parallel Pattern for Wreath-piece over Six Treads; also Showing the Squaring of the Wreath-piece at the Joints.—Make W M and W C each equal W Q of Fig. 2; draw W L at right angles to W M; make W L equal W K of Fig. 2; connect L M and L C; make the joints C and M at right angles to the tangents; make C 18, 20, 22 equal the same at Fig. 2; make L, 24, 26 and 28 equal K, 24, 26 and 28 of Fig. 2; parallel to L W draw 28, 8; 26, 7; 24, 6; 22, 5; 20, 4; make 20, 4 equal 19, 4 of Fig. 2; make 22, 5 equal 21, 5 of Fig. 2; make 24, 6 equal 23, 6 of Fig. 2; make 26, 7 equal 25, 7 of Fig. 2; make 28, 8 equal 27, 8 of Fig. 2. Through C, 18, 4, 5, 6, 7, 8, M as centres with a radius equal to one half the width of the required pattern describe circles, and, touching these, trace the curved edges of the pattern. Both joints of this wreath-piece are squared by the bevel at 31 of Fig. 2.

Fig. 7. Parallel Pattern for Wreath-piece Joining the Newel at the Starting, and Including the Two First Treads; also Showing the Squaring at the Joints of the Wreath-piece.—Make A D equal A E of Fig. 1. On D as centre with D B of Fig. 1 as radius describe an arc at B; on A as centre with A B of Fig. 1 as radius intersect the arc at B; connect B D and B A; make the joints A and D at right angles to the tangents; make B, 17, 15 equal the same at Fig. 1; make 17, 1 and 15, 2 equal 16, 1 and 14, 2 of Fig. 1; through A, 1, 2, D as centres with a radius equal to one half the required width of pattern describe circles, and, touching these, trace the edges of the pattern. The angle with which to square the wreath-piece at joint D is taken by the bevel F at Fig. 1, and for joint A the angle is taken by the bevel I of Fig. 1. *Face-moulds and parallel patterns are treated in detail at the following Plates:* Fig. 5 *at* Plate No. 14; Fig. 6 *at* Plate No. 15; Fig. 7 *at* Plate No. 13. *Development of the centre lines of wreaths is given in detail at the following Plates and Figures:* Fig. 5 at Plate No. 21, Figs. 1 *and* 2, *and of* Fig. 6 *at the same Plate*, Figs. 7 *and* 8; Fig. 7 *at* Plate No. 20, Figs. 5 *and* 6.

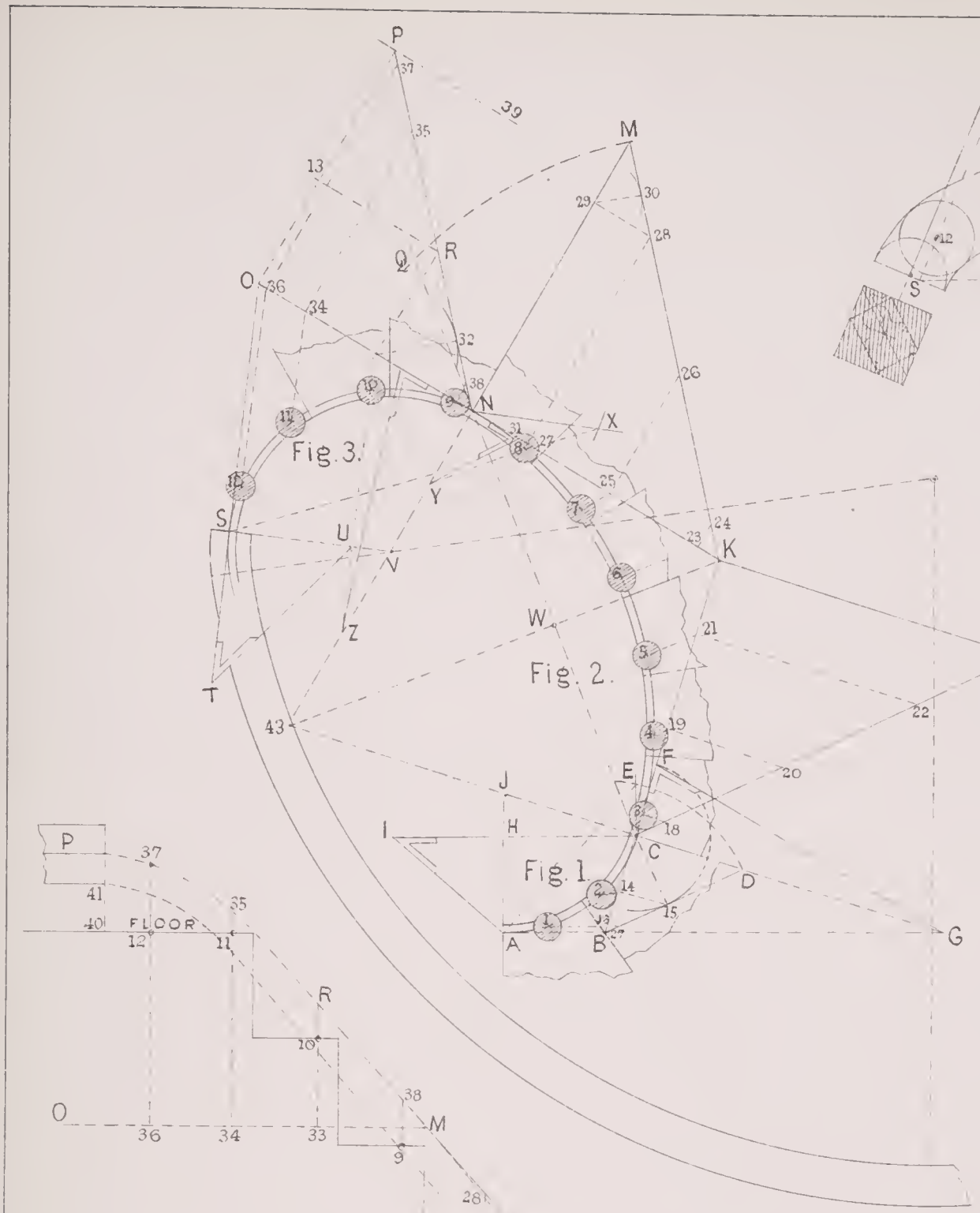


Fig. 1.

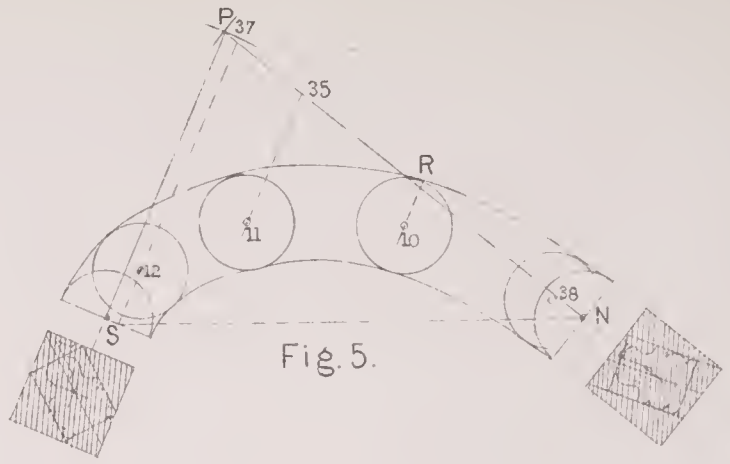


Fig. 5.

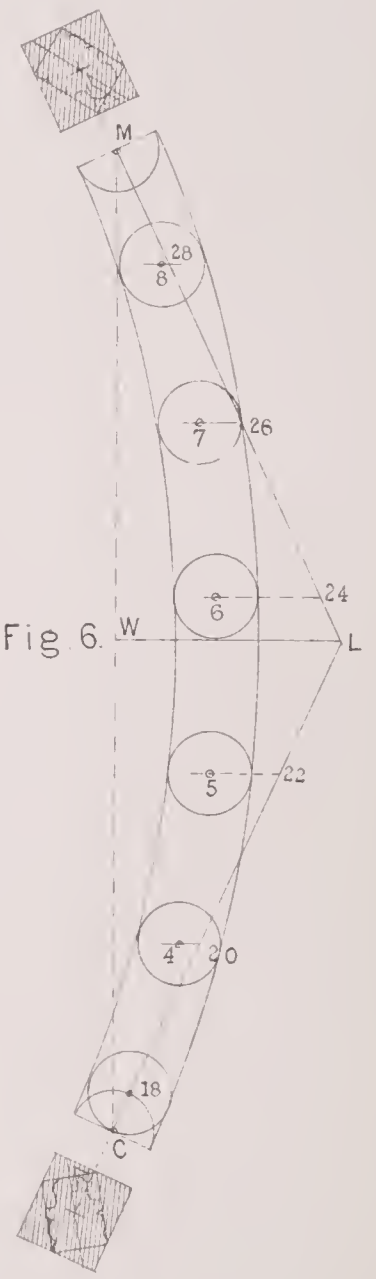


Fig. 6.

Fig. 4.

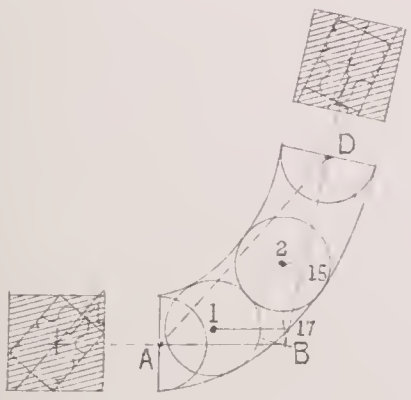


Fig. 7.

SCALE ¾ IN. = 1 FT.

PLATE 51.

Fig. 1. Plan of Stairs Showing how to Place Parallel Steps of a Uniform Width in a Large Cylinder, Avoid Winders, and Make Use of the Room Afforded by Securing a Full Platform; also an Evenly-graded Hand-rail in Three Parts, Free from Abrupt Top Curves or Ramps.—This plan is given at PLATE No. 6, FIG. 8. Describe the centre line of rail; set off and number the balusters coming within the cylinder as shown. Divide the cylinder into three equal parts by the radials R, 29, and R 1; draw tangents to the centre line of rail as follows: At right angles to R U draw U 16; through A at right angles to R, 29 draw 16 B; through 10 at right angles to R 1 draw B 35; at right angles to R 42 draw 43, 35; at right angles to A B draw B D indefinitely; at right angles to B 35 draw 35, 34 indefinitely; at right angles to U 16 draw 16, 15 indefinitely. Further measurements required will be obtained from the elevation.

Fig. 2. Elevation of Treads and Rises as given at Plan Fig. 1; also the Development of the Centre Line of Wreath.—Place the centre of baluster on each step and number them as at the plan. Through each of the centres draw lines parallel to the rise-lines indefinitely. Let the bottom line of rail at the upper and lower ends pass through X X and 1 X, the centres of short balusters; parallel to X X draw the centre line of rail B 34; parallel to 1, X draw the centre line of rail A 15; at right angles to the chord-line draw U 45; make U 45 equal the tangent U 16 of FIG. 1; parallel to the chord-line draw 45, 15; parallel to U 45 draw 15 F indefinitely; make 43, 34 equal 43, 35; parallel to the chord-line draw 34 F; draw 34, 43 at right angles to the chord-line; divide F 34 into four equal parts and draw lines through each division parallel to F 15 indefinitely. Make 42 B and U A each three inches for straight wood to be added to the upper end of one and the lower end of the other wreath-piece, connecting with the straight rail. Again, at FIG. 1, make 16, 15 equal 16, 15 of FIG. 2; connect 15, U; make 43, 42 equal the same at FIG. 2; connect 42, 35. Set up the following heights: 35, 34; 10, 1; B D and A 29—each equal one of the four equal heights at 34 F of FIG. 2. Connect 34, 10; 1 B, D A and 29, 16; make 42, 44 equal 35, 34; draw 44, 38 parallel to 43, 35; make 38, 36 parallel to 43, 42; draw 43, 37 parallel and equal to 35, 10; connect 36, 37; parallel to 36, 37 draw 11, 30, 12, 32 and 13, 39; parallel to 43, 42 draw 14, 41, 39, 40 and 36, 38; parallel to 35, 34 draw 32, 33 and 30, 31. Make 16, 17 equal A 29; draw 17, 19 parallel to 16 U; draw 19, 23 parallel to 16, 15; make U 25 parallel and equal to 16 A; connect 25, 23; parallel to 25, 23 draw 4, 26, 3, 24 and 2, 20. Parallel to A 29 draw 5, 28 and 26, 27; parallel to 16, 15 draw 24, 18; 20, 21 and 1, 22. At the middle piece of hand-rail describe half its width each side of the centre line. Through A and 10 draw A O indefinitely; at right angles to A 10 draw B P; parallel to B P draw E F, Y T, 8 C and 7 N; parallel to B D draw N M and 6 L; parallel to 10, 1 draw X H, Z G and C K; on B as centre with B 1 as radius describe the arc 1, O.

To Find the Angle with which to Square the Wreath-piece at Both Joints:—Prolong T Y to W; draw G J parallel to 10 B; make 10 S equal J H; connect S W: then the bevel at S contains the angle required. Again, at FIG. 2, take all the heights from the plan tangents at FIG. 1 and place them on the lines drawn through the centres of like-numbered balusters, and as shown by the other corresponding numbers and letters; and through the top numbers and letters trace the centre line of wreath. The odd lengths of balusters will be found as before explained.

Fig. 3. Face-mould for the Middle Piece of Hand-rail; also Showing the Squaring of the Wreath-piece at the Joints.—Make V O and V A each equal V O of FIG. 1; make P D equal P B of FIG. 1; connect A D and O D: make D G H and D G H equal B G H of FIG. 1. Parallel to P D through G, H and G, H draw E F and Y T; make D Q V equal B Q V of FIG. 1; make G T, G Y, G T, G Y equal Z T, Z Y of FIG. 1; make H F, H E, H F, H E equal X F, X E of FIG. 1; through A draw E S; make A S equal A E; through O draw E B; make O B equal O E. Make the joints A and O at right angles to the tangents. Through S F T Q T F B of the convex and E Y P Y E of the concave trace the curved edges of the face-mould. The angle for squaring the wreath-piece at joints O and A is taken by the bevel S of FIG. 1.

Fig. 4. Plan of the First Third of the Wreath, with the Tangents and Angles of Inclination from U to A of Fig. 1.—Make U K parallel and equal to 16 A; make 16, O equal A 29; make O N parallel to U 16; make N M parallel to 15, 16; connect M K, the directing level line; parallel to M K draw Q S, W L, 16 D, Z F and J 1; parallel to Q 29 draw V T and X Y; parallel to 16, 15 draw 2, 4 and 6, 3; at right angles to K M draw A B and U H; on 16 as centre with 16, 29 as radius describe the arc 29 B; again, on 16 as centre with U 15 as radius describe an arc at H; connect H B.

To Find the Angle with which to Square the Wreath at the Joint over A:—Make A E equal A T; connect E D: then the bevel at E contains the angle required.

To Find the Angle with which to Square the Wreath at the Joint over U:—Draw F G at right angles to F U; make F G equal 2, 5; connect G U: then the bevel at G contains the angle sought.

Fig. 5. Face-mould over the Plan Fig. 4, also Showing the Squaring of the Wreath-piece at the Joints.—Make B C H equal B C H of FIG. 4; on H as centre with U 15 of FIG. 4 as radius describe an arc at 16; on C as centre with C 16 of FIG. 4 as radius intersect the arc at 16; connect B 16, C 16 and 16 H; make 16, 2, 3 equal 15, 4, 3 of FIG. 4; make 16, Y, T equal 16, Y, T of FIG. 4; parallel to C 16, through T, Y, 2, 3, draw J 1, 8 Z, W L and Q S; make 3, 1, 3 J, 2 Z, 2 8 equal 6 1, 6 J, 2 Z and 2, 8 of FIG. 4; make 16, P, G equal 16, P 9 of FIG. 4; make Y L, Y W, T S and T Q equal X L, X W, V Q, V S of FIG. 4. Through H draw J E; make H E equal H J; through B draw Q F; make B F equal B Q; make H D equal U A or 42, B of FIG. 2. Make the joints D and B at right angles to the tangents. Draw lines from E and J to joint D parallel to 16, H; through E 1 Z P L S F of the convex and J 8 C W Q of the concave trace the curved edges of the face-mould. Make the slide-line at right angles to the level line C 16. Joint B of the wreath-piece is squared by the bevel at E of FIG. 4, and joint D is squared by the bevel at G of FIG. 4. A face-mould geometrically the same as FIG. 3 is given in detail at PLATE No. 15, and a face-mould geometrically the same as FIG. 5 is also given in detail at PLATE No. 16. Development of the centre line geometrically the same as the centre line of this wreath-piece from U to A of FIG. 1 is given in detail at PLATE No. 21, FIGS. 9 and 10; also an example of the development of a centre line of wreath from A to 10 of FIG. 1 is given geometrically the same in the last-mentioned Plate, FIGS. 7 and 8.

PLATFORM

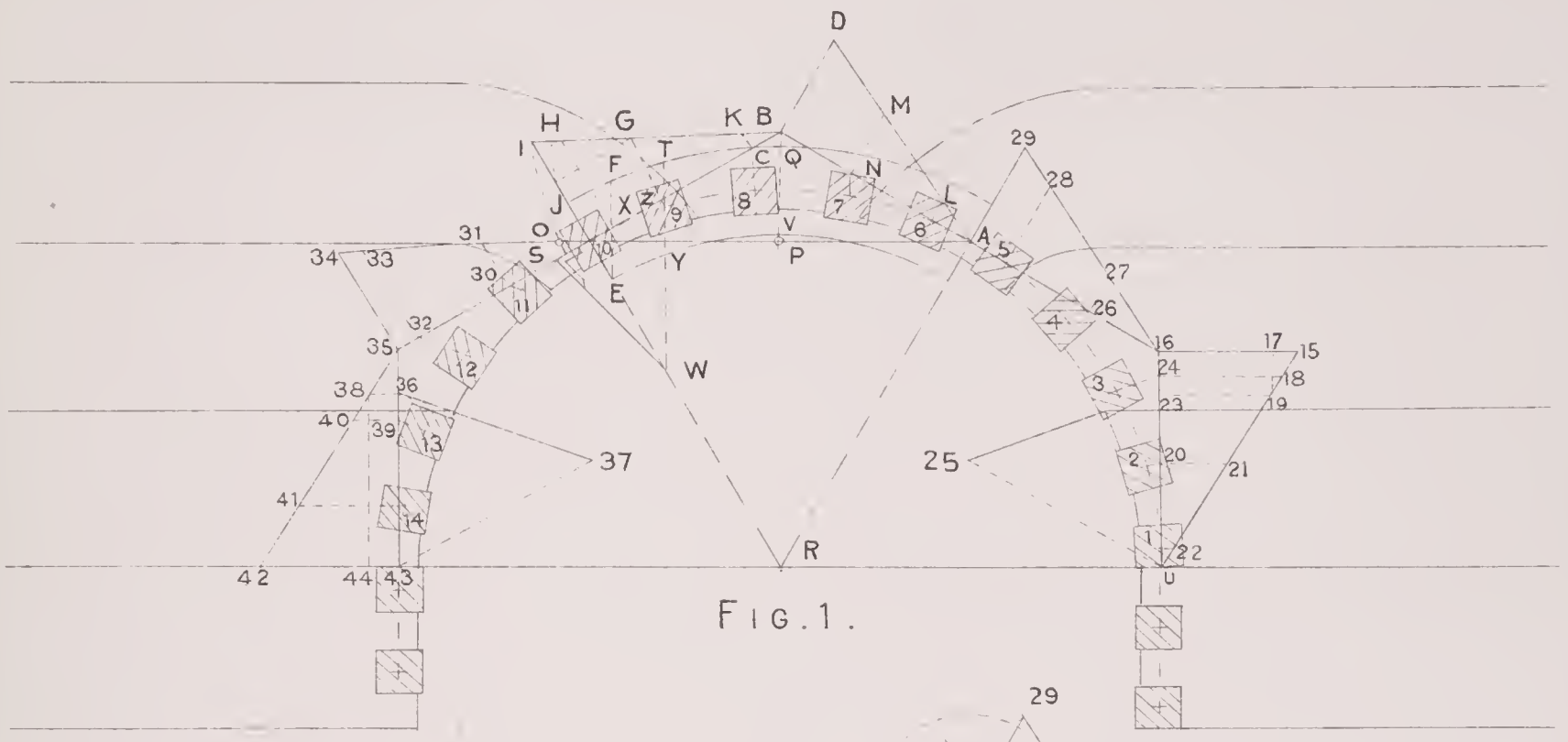


FIG. 1.

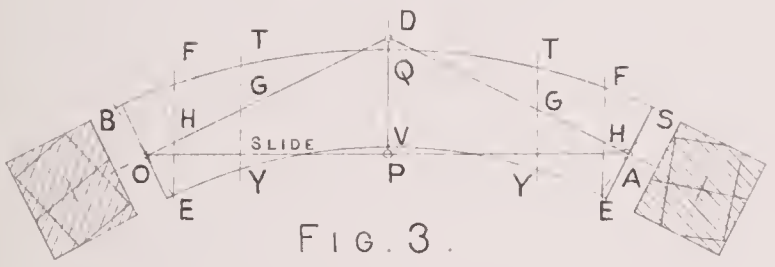


FIG. 3.

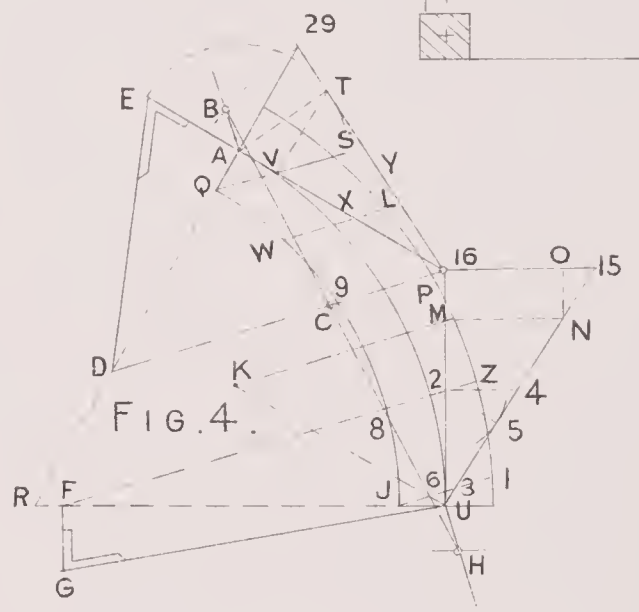


FIG. 4.

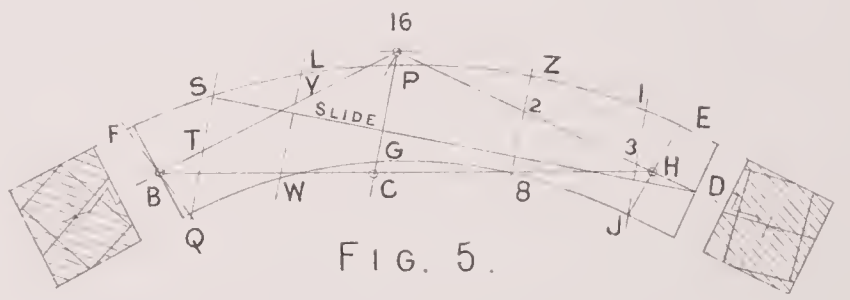


FIG. 5.

FIG. 2.

SCALE 3/4 IN. = 1 FT.

PLATE 52.

Fig. 1. Plan of a Platform and Double-landing Steamship Staircase with Newels at the Starting, at the Angles of the Platform and at the Landings.—The posts at the starting are intended to run above the upper deck a sufficient height to receive the level hand-rail and balustrade of that deck as shown by the dotted lines. All the newel-posts are to be finished above the hand-rails with moulded caps, the landing-post also finished with moulded drops below the strings. The platform-posts are to rest on the lower deck. A plan of a staircase similar to this with a continued hand-rail is given at PLATE No. 6, FIG. 9, the hand-rail of which is treated at PLATE No. 50.

Fig. 2. Elevation of Treads and Rises between the Starting Newel and the Platform Newel.—The treads in the curve from A to F on the plan must be measured on the centre line of rail in the manner before directed,—taking each tread in two parts. Place the centres of the three balusters in the curve as numbered in position on each tread, and through these draw lines parallel to the rise-lines indefinitely. Make A E equal A D of FIG. 1 through E draw E D parallel to the rise-lines; make D F equal D F of FIG. 1; continue the tread-line M to F and Z; from X, the centre of baluster, with a radius equal to half the thickness of rail describe an arc at U; touching U draw a line to F; at E draw the line E A at right angles to E D; through X parallel to U F draw the bottom line of rail X C; make B N equal 3″ for straight wood to be left on the upper end of the wreath-piece. At right angles to F E draw F W; make F W equal half the thickness of rail; draw W Y parallel to E F.

Fig. 3. Plan of Rail with Centre Line and Tangents taken from A to F of Fig. 1.—Make A B at right angles to A D and equal A B of FIG. 2. Connect B D; at right angles to D F draw D E equal to D E of FIG. 2; connect E F; connect D K; through A draw F C indefinitely; on D as centre with D B as radius describe the arc B C. The numbers 1, 2 and 3 designate the centres of the first three balusters as placed on the treads at FIG. 1. Parallel to G D draw P Q, 3, O and 2 Z; parallel to D E draw Z T and 1 R.

To Find the Angle with which to Square the Wreath-piece at Both Joints:—Prolong D F to J indefinitely; make F J equal D H; connect J K; then the bevel at J contains the angle sought. Again, at FIG. 2, take the heights O V, Z T and 1 R from FIG. 3 and place them at the like-numbered balusters as shown; then through M R T V B trace the centre-line of wreath-piece; below this centre line set off half the thickness of rail for the bottom line of wreath. Find the odd lengths of balusters as before explained, first fixing the length of baluster at X to suit, which should not be less than 2′.4″ from top of step to the bottom of rail at the centre of baluster.

Fig. 4. Face-mould from Plan Fig. 3; also Showing the Squaring of the Wreath at the Joints.—Make G C, G C each equal G C of FIG. 3. Draw G D at right angles to G C; make G D equal G D of FIG. 3; connect D C, D C, and prolong each indefinitely; make C Y equal W Y of FIG. 2; make C N equal B N of FIG. 2; make the joints N and Y at right angles to the tangents; make D U, D U each equal D U of FIG. 3. Parallel to G D draw U P, U P; make U P, U P each equal Q P of FIG. 3; make D X X equal D X X of FIG. 3; through C and C draw P L and P L; make C L and C L equal C P; draw lines from P and L to the joints parallel to the tangents; through L X L of the convex and P X P of the concave trace the curved edges of the face-mould. The dotted lines show the extra width of wood required—greater than the width of face-mould—to get out the wreath-piece with this proportioned form of hand-rail. This wreath-piece is squared at the joints Y and N by the angle at bevel J of FIG. 3. An elementary study of a face-mould geometrically the same as this is given at PLATE No. 15; also a like study of the development of a centre line of wreath geometrically the same as at FIG. 2 is given at PLATE No. 21, FIGS. 7 and 8.

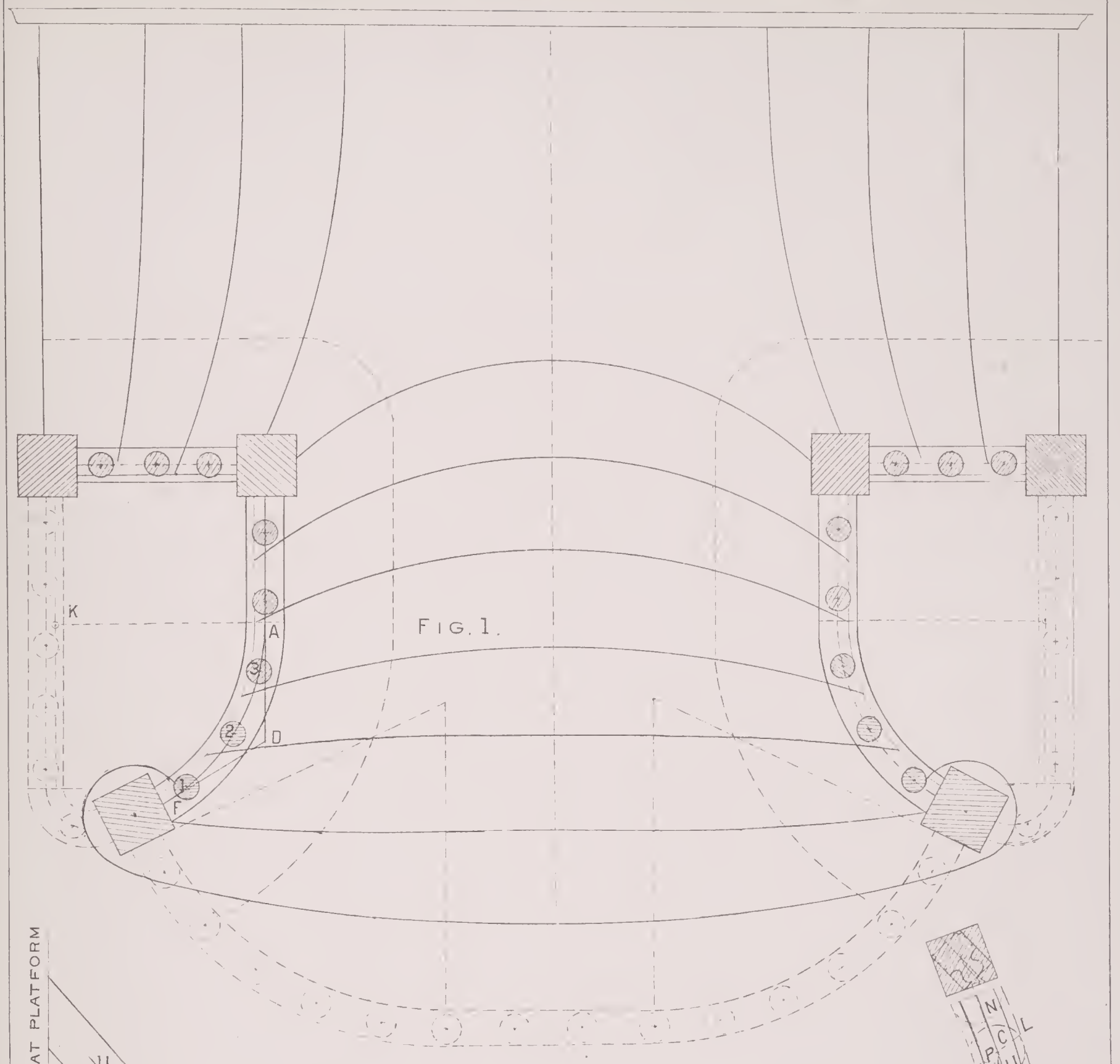


FIG. 1.

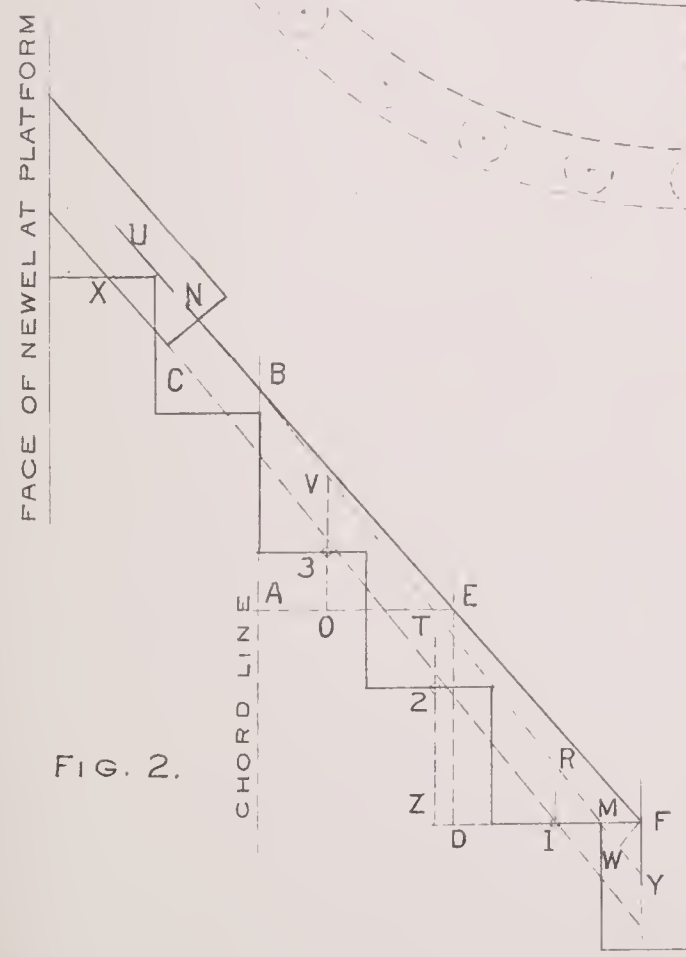


FIG. 2.

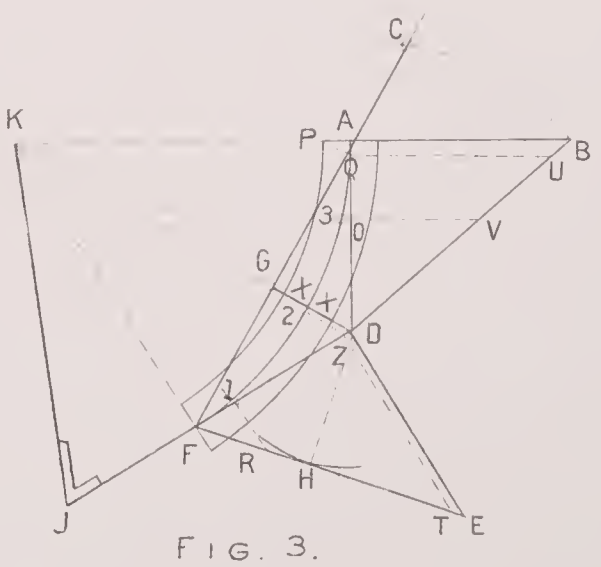


FIG. 3.

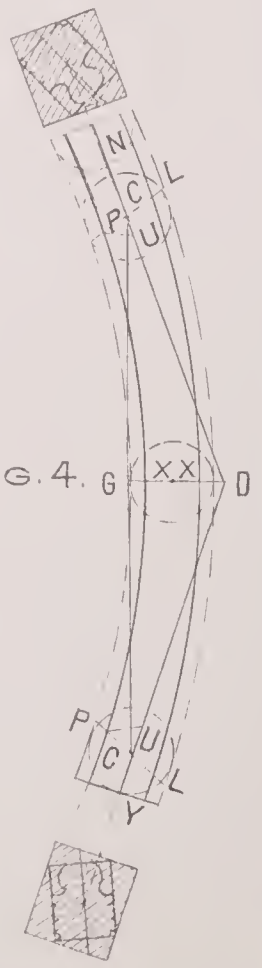


FIG. 4.

SCALE $\frac{3}{4}$ IN = 1 FT.

PLATE 53.

Hand-rail for Circular Staircase from Plan given at Plate No. 7, Fig. 10.—Figs. 1, 2 and 3 are together the plan of the string with its curves, including the whole number of treads. Describe the centre line of rail $\frac{3}{4}''$ greater radius than the front-string. The hand-rail of this flight is divided into five parts: Fig. 1 from the newel-post A to D embraces three treads, and three more divisions of the hand-rail will each include five treads; the fifth piece of rail will take the last tread, and as much more of the curve as it requires to bring this top wreath-piece to a level at its proper height. Draw the tangents to the centre line of rail as follows: At right angles to the radial Y E, touching D, draw B 1; at right angles to the radial Y C, touching C, draw 1 F; at right angles to the radial Y L, touching L, draw 4 F; at right angles to Y X, touching X, draw U 4; at right angles to D 1 draw 1, 2; make 1, 2 equal two rises and a half, the rise being $7\frac{1}{4}''$; connect 2 D; make C 3 and F E each at right angles to 1 F, and each equal to two and a half rises; connect 3, 1, also E C; at right angles to F 4 draw 4, 5; make 4, 5 and L J each equal two and a half rises; connect 5 L, also J F; make X 6 equal two and a half rises; connect 6, 4. At Fig. 2, through L draw C K indefinitely; on F as centre with F J as radius describe the arc J K; from M parallel to Y F draw M N, Q R and H F; parallel to L J draw O T and P S.

To Find the Angle with which to Square the Wreath-piece at Both Joints:—Parallel to F Y draw A G; at right angles to Y C draw A B; make A B equal G D; connect B C: then the bevel at B contains the angle sought. At Fig. 1 the curve of string which includes the two first treads has a radius I Z equal to one foot; also, the limit of tangents D B and B A cannot be determined until a portion of the elevation is set up; neither can the tangents X U and U B of Fig. 3 be fixed, for the same reason.

Fig. 4. A Portion of an Elevation of Treads and Rises, including the Three First Treads, the Top Tread, and Landing.—Let the bottom line of rail pass through X X X, the centres of balusters; make W T equal 8″, and T Z half the thickness of rail; draw Z D parallel to line of tread; prolong the fourth line of rise to C and D; draw C U at right angles to C D indefinitely; make S E equal 4″, and E V half the thickness of rail. Again at Fig. 1, make D C equal D C of Fig. 4; parallel to 2 D draw C B; from B draw the tangent B A, touching the centre line of rail; from I at right angles to B A draw I A; from D at right angles to B A draw D H indefinitely; on B as centre with B C as radius describe the arc C H; connect H A; parallel to B A draw P Q, R X and V W; parallel to D E draw O F, S M and U N.

To Find the Angle with which to Square the Wreath-piece at the Joint over D:—Parallel to A B prolong R X to E; from S draw S L parallel to B C; make D G equal D L; connect G E: then the bevel at G contains the angle sought.

To Find the Angle with which to Square the Wreath-piece at the Joint over A:—Let D J be parallel to B A; make K J equal D C; connect J A: then the bevel at J will contain the angle required. At Fig. 3, make U V equal U V of Fig. 4; draw V W parallel to U X; from X parallel to 6, 4 draw X V; from V at right angles to X U draw V U; from U draw U C, touching the centre line; from Y at right angles to U C draw Y B; from X at right angles to U B draw X H indefinitely; with X V as radius on U as centre describe an arc at H; parallel to B U draw A G, E K and X D.

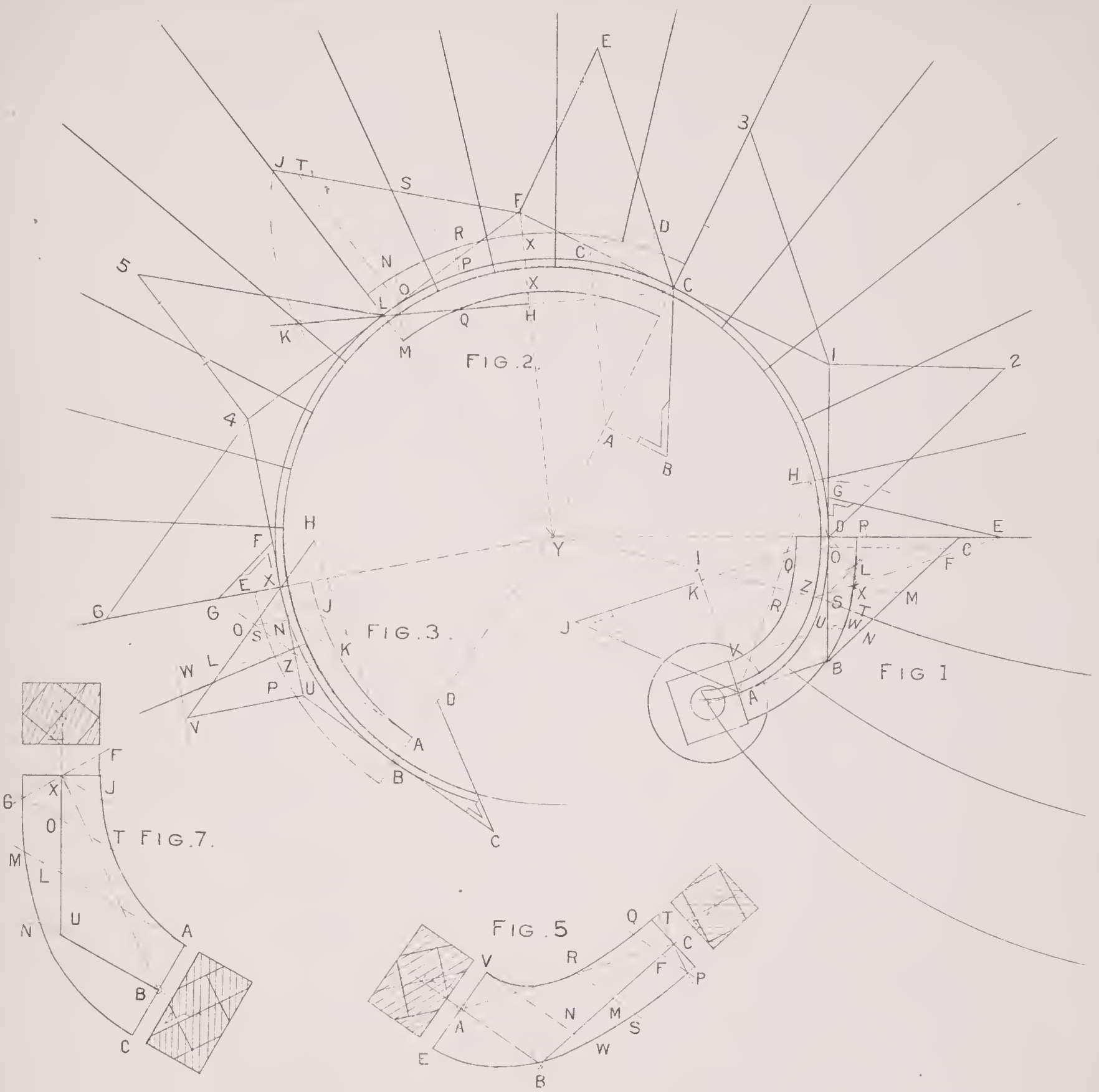
To Find the Angle with which to Square the Wreath-piece at the Joint over X:—Make X F equal Z O; connect F G: then the bevel at F contains the angle sought.

To Find the Angle with which to Square the Wreath-piece at the Joint over B:—Make B C equal U V; connect C D: then the bevel at C contains the angle required.

Fig. 5. Face-mould from Plan Fig. 1; also Showing the Squaring of the Wreath-piece at the Joints.—Make C A equal A H of Fig. 1. On C as centre with C B of Fig. 1 as radius describe an arc at B; on A as centre with A B of Fig. 1 as radius intersect the arc at B; connect C B and B A; make C F M N equal the same at Fig. 1; parallel to A B through F M and N draw V W, R S and Q P; make F Q and F P equal O Q and O P of Fig. 1; make M R and M S equal S R and S X of Fig. 1; make N W equal U W of Fig. 1; through C draw P T; make C T equal C P; make the joints A and C at right angles to the tangents; make A E equal A V; through P S W B E of the convex and T Q R V of the concave trace the curved edges of the face-mould. This wreath-piece is squared at the joint C by the angle at bevel G of Fig. 1, and at joint A is squared by the angle at bevel J of Fig. 1.

Fig. 6. Face-mould from Plan Fig. 2; also Showing the Squaring of the Wreath-piece at the Joints.—Make H K, H K each equal H K of Fig. 2; make H F at right angles to H K, and equal to H F of Fig. 2; connect F K and F K; make F S T and F S T equal the same at Fig. 2; parallel to H F through S T and S T draw M N, Q R and M N, Q R; through K and K draw M Z and M Z; make K Z, K Z each equal M K; make F O O equal F X X of Fig. 2; make S R, S Q, T N, T M each side of the centre O O equal P R, P Q, O N and O M of Fig. 2; make the joints K, K at right angles to the tangents; through Z N R O R N Z of the convex and M Q O Q M of the concave trace the curved edges of the face-mould. This wreath-piece is squared at both joints by the angle at bevel B of Fig. 2.

Fig. 7. Face-mould from Plan Fig. 3; also Showing the Squaring of the Wreath-piece at Both Joints.—Let B X equal B H of Fig. 3. On B as centre with B U of Fig. 3 as radius describe an arc at U; on X as centre with X V of Fig. 3 as radius intersect the arc at U; connect X U and U B; make the joints B and X at right angles to the tangents; make X O L equal X O L of Fig. 3; parallel to B U and through X, O, L draw X J, T G and A M; make U N and L M equal U P and Z S of Fig. 3; make X J, O T, O G equal X J, N K, N E of Fig. 3; make B C equal B A; through X draw G F; make X F equal X G; through G M N C of the convex and A T J F of the concave trace the curved edges of the face-mould. The angle with which to square the wreath-piece at joint X is taken by the bevel F at Fig. 3, and for joint B the angle is taken by the bevel at C. An elementary study of a face-mould geometrically the same as Figs. 5 and 7 is given at Plate No. 13, and of face-mould Fig. 6 at Plate No. 15. A like study of the development of a centre line of wreath-piece geometrically the same as required for Figs. 5 and 7 is given at Plate No. 20, Figs. 5 and 6; also the development of a centre line of wreath-piece geometrically the same as required for Fig. 6 is given at Plate No. 21, Figs. 7 and 8.



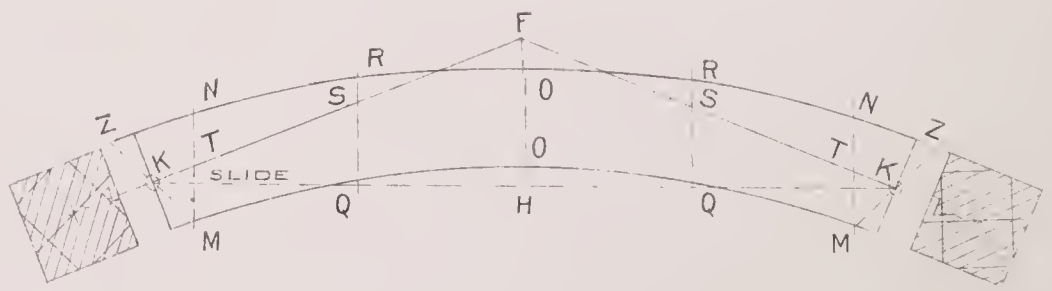


FIG. 6.

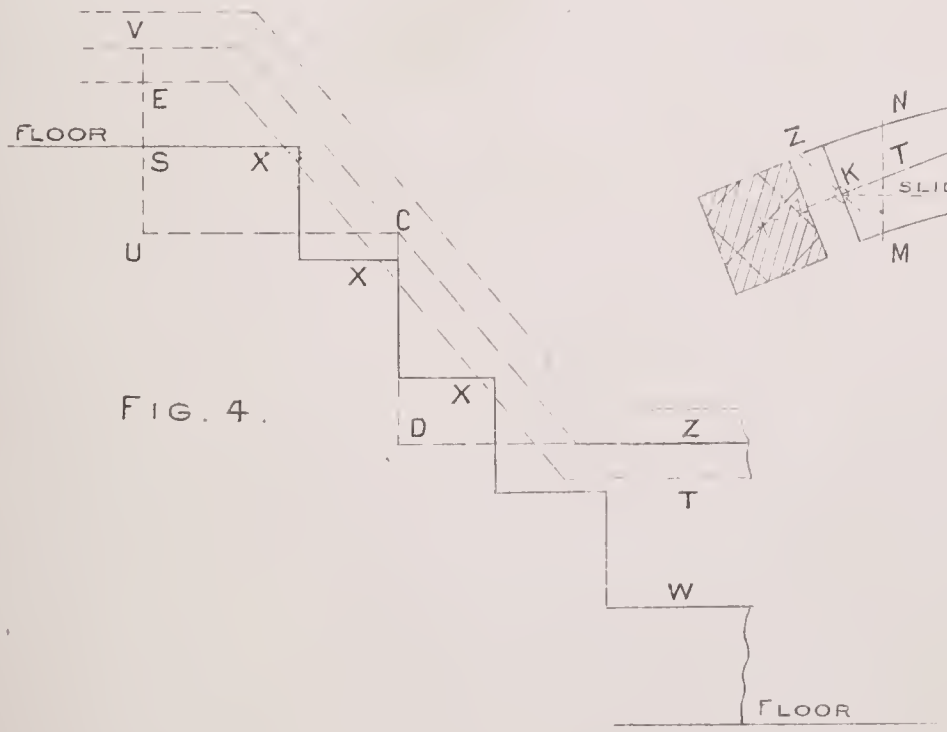


FIG. 4.

SCALE $\frac{3}{4}$ IN. = 1 FT.

PLATE 54.

Fig. 1. Plan of Starting the Circular Staircase given at Plate No. 53, with a Scroll Step and Hand-rail instead of a Newel.—The first three steps in this plan are all included in the curve of the scroll, but the bottom step is properly the scroll step. The radius Y D is the same as that of the plan of circular string, PLATE No. 53. D 2, 1 is equal to D 2, 1 at the plan, PLATE No. 53. Touching D, the tangents 1 A are at right angles to Y D; at right angles to D A, touching the centre line of rail at F, draw A F; make the joint F at right angles to F A; from A parallel to D 2 draw A E; parallel to V E draw U H, I C and G B.

To Ascertain the Height of the Scrolled Hand-rail, as Regulated by the Tangent D A and the Angle of Inclination D E A:—Set up an elevation of the first three treads, including the fourth rise as at FIG. 2. Let X be the centre of baluster, and let the bottom line of rail pass through X; also let D E A equal D E A of FIG. 1. Make A B half the thickness of rail; then B C, which is $4\frac{1}{2}''$, added to whatever height of baluster is given at X, will be the total height of scrolls between the top of the first step C and the bottom of the scroll B when the rail is set up. The scroll looks best when kept at a height between C and B not exceeding 2′.6″. In shaping the top and bottom of the scroll it is desirable not to finish to a level at the joint F, but to continue the easing an inch or two lower down, coming to a level with its easement at about the eye of the scroll. The scroll may also be brought lower by increasing the length of tangent D A of FIG. 1, forming an acute angle with the plan tangents; or it may be fixed at a greater height by lessening the length of tangent D A, and forming an obtuse angle with the plan tangents.

Fig. 3. Face-mould from Plan of Scroll Fig. 1; also Showing the Squaring of the Wreath-piece at the Joints.—Let E A equal E A of FIG. 1; make A F at right angles to A E and equal to A F of FIG. 1; make E H C B equal the same at FIG. 1; through E H C B parallel to F A draw V V, U M, I L and G B; make E V, E V, H U, H M, C I, C L, B K and A J equal D V, T U, T M, O I, O L, S K and A J of FIG. 1. Through F draw G P parallel to A E; make F P equal F G; through P J K L M V of the convex and V U I G of the concave trace the curved edges of the face-mould. This wreath-piece is squared at the joint F by the angle at bevel E of FIG. 1. At joint E the sides of the wreath are at right angles to the plane of the plank.

Fig. 4. To Draw a Scroll suitable for this Hand-rail and Staircase.—Describe a circle of a diameter about sufficient to enclose the spiral line to be developed—its exact diameter is unimportant. Divide the circumference of the circle into sixteen parts; make the diameter of the eye of the scroll S J equal the width of the hand-rail. The spiral curve is found by points on these sixteen radii, beginning at J by drawing a line at right angles to the radial A J, then at right angles to the next radial on the left, and so on as shown by the position of the little trying-squares, the external angles of which designate points on which as centres with half the width of rail as radius describe arcs of circles. Touching these arcs trace the curved edges of the scroll; but at the point O where the arc touches the eye of the scroll measure on the radii from the external angles of the squares to the circle forming the eye, and set off these distances outward as at O O, S S, etc., to J, tracing the remainder of the convex curve from O to J through the points thus found. The spiral drawn in this way may be cut off at any point where a sufficient revolution is made. In this case it is cut off at D and connected with the plan at D. FIG. 1.

Fig. 5. Construction of Block for Scroll Step and Riser.

Fig. 6. Scroll Step as Completed.

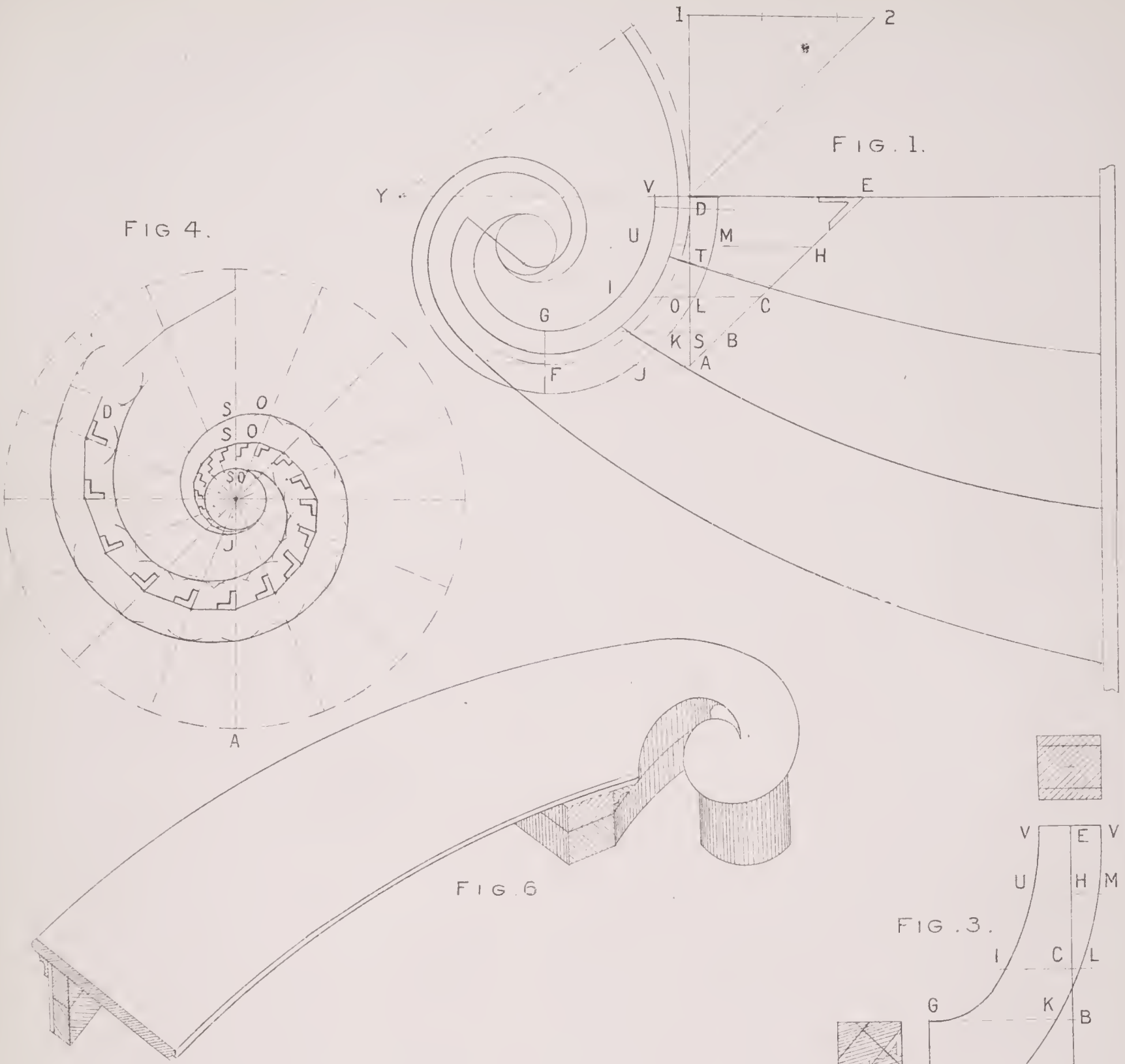


FIG. 1.

FIG 4.

FIG. 6

FIG. 3.

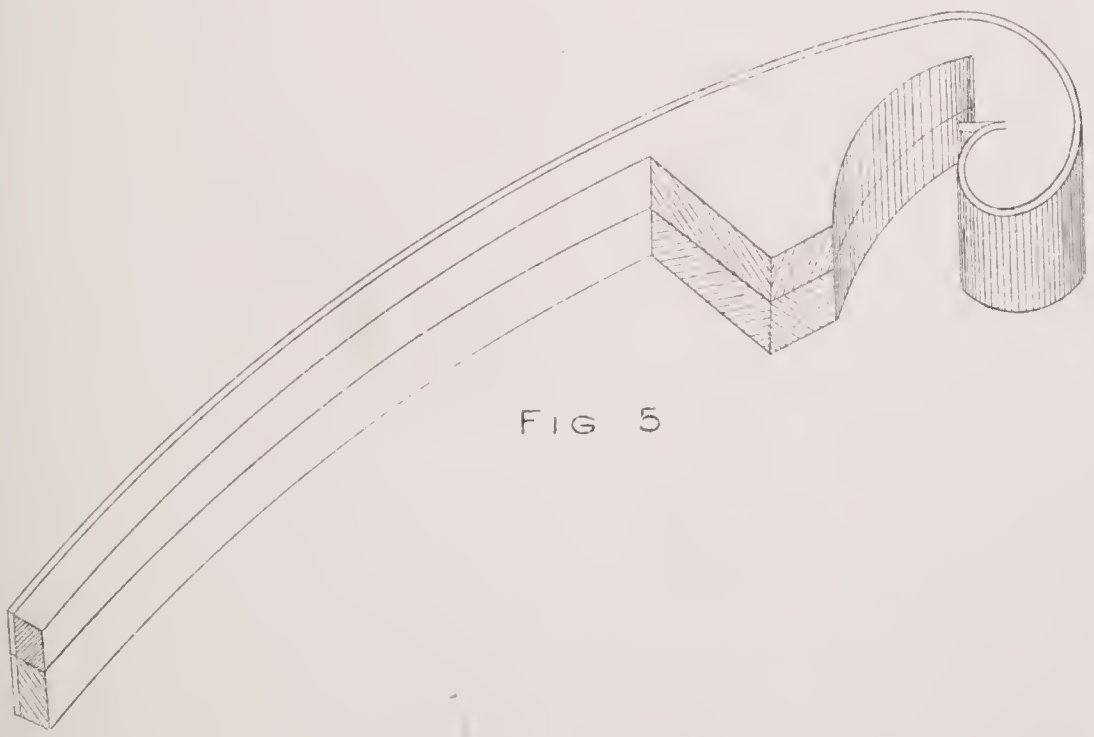


FIG 5

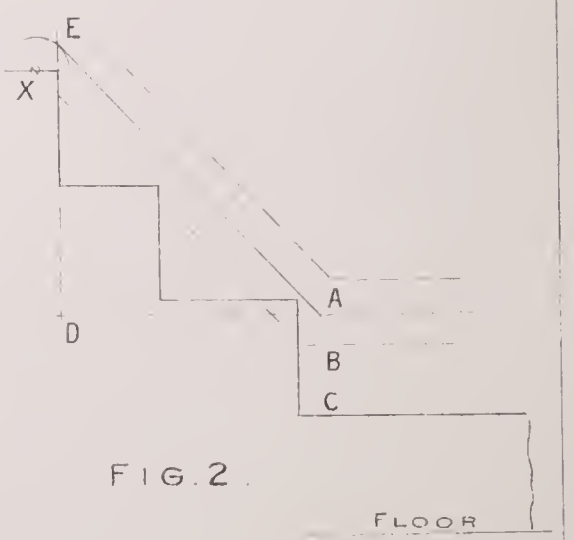


FIG. 2.

SCALE $\frac{3}{4}$ IN. = 1 FT.

PLATE 55.

Hand-rail over Elliptic Staircase from the Plan given at Plate No. 7, Fig. 11.—The best division of hand-rail for this plan is to begin at the centre, FIG. 1, taking in this first piece a portion of rail including three treads each side of the minor axis; then FIG. 3, covering four more treads, FIG. 5, also taking four treads; and FIG. 8, with the bottom tread and as much more of the curve as may be required to join the level rail at its usual height. After deciding on the proper number of pieces in which to divide the plan of hand-rail, draw the tangents for the whole as follows. Make **B V** tangent to the centre of rail at **V**, draw **B N** tangent to the centre line of rail at **Y**; draw **N A** tangent to the centre line of rail at **W**; draw **A L** tangent to the centre line of rail at **C**; the level tangent **L F** will be fixed further on.

Fig. 1. Plan of Wreath-piece including Six Treads.—Draw **B X** at right angles to **B Y** and equal to three rises; connect **X Y**, at right angles to **B V** draw **V A** equal to three rises; join **A B**, prolong **A V** to **F** indefinitely; from **Y** through **V** draw **Y D**; on **B** as centre with **B A** as radius describe the arc **A D**; parallel to **B N** draw **M K**, **S R** and **W T**; parallel to **V A** draw **U 5**, **Q G** and **L J**.

To Find the Angle with which to Square the Wreath-piece at Both Joints:—Prolong **R S** to **F**, parallel to **B V** draw **G H**; make **V E** equal **H C**; join **E F**, then the bevel at **E** contains the angle sought.

Fig. 2. Face-mould from Fig. 1; also Showing the Squaring of the Wreath-piece at the Joints.—Let **N A** and **N A** each equal **D N** of FIG. 1, make **N B** at right angles to **N A** and equal to **N B** of FIG. 1; join **B A** and **B A**; make **B J G 5** equal the same at FIG. 1. Through **J G 5** draw **K M**, **R S** and **T W** parallel to **N B**; make **B P**, **J K** and **J M** equal **B P**, **L K** and **L M** of FIG. 1; make **G R**, **G S**, **5 T** and **5 W** equal **Q R**, **Q S**, **U T** and **U W** of FIG. 1. Apply the same measurements the other side of the centre **B P**, and through all these points trace the curved edges of the face-mould. Make the joints **A A** at right angles to the tangents. This wreath-piece is squared at both joints by the angle at bevel **E** of FIG. 1.

Fig. 3. Plan of Wreath-piece including Four Treads.—Draw **Y R** at right angles to **Y N** and equal to four rises. Parallel to **Y X** draw **N I**; at right angles to **A N** draw **W 5** and **N, 14**; make **N, 14** equal **1 R**; join **14, W**; draw **W J** parallel and equal to **N Y**; make **1 S** equal **14, N**; parallel to **Y N** draw **S G**; make **G 8** parallel to **1 Y**; join **8 J** parallel to **8 J** draw **T M**, **2, 9 N K**, **7, 22** and **10, 11**; parallel to **Y I** draw **O F** and **D 3**; parallel to **N, 14** draw **U P** and **C I**; at right angles to **J 8** draw **Y Z**; on **N** as centre with **N I** as radius describe the arc **1 Z**; at right angles to **J 8** draw **W B**, on **N** as centre with **W 14** as radius describe an arc at **B**; join **B Z**.

To Find the Angle with which to Square the Wreath-piece at the Joint over Y:—Draw **3 A** parallel to **N Y**, make **Y E** equal **A 4**; join **E 2**: then the bevel at **E** contains the angle sought.

To Find the Angle with which to Square the Wreath-piece at the Joint over W:—Parallel to **J 8** prolong **7, 22** to **5**; make **W X** equal **U Q**; join **X 5**; then the bevel at **X** contains the angle required.

Fig. 5. Face-mould from Plan Fig. 3; also Showing the Squaring of the Wreath-piece at the Joints.—Make **Z L B** equal **Z L B** of FIG. 3; on **B** as centre with **W, 14** of FIG. 3 as radius describe an arc at **N**; on **L** as centre with **L N** of FIG. 3 as radius intersect the arc at **N**; join **B N**, **N Z** and **L N**; make **B I P** equal **W I P** of FIG. 3; make **N 3 F** equal **N 3 F** of FIG. 3; through **I P**, **3 F** parallel to **L N** draw **11, 10, 7, 22, H S** and **T M**; make **I 10**, **I 11**, **P 22**, **P 7**, **N 12**, **N K** equal **C 10**, **C 11**, **U 22**, **U 7**, **N 12**, and **N K** of FIG. 3; make **3 9**, **3 H**, **F M**, **F T** equal **D 9**, **D H**, **O M** and **O T** of FIG. 3. Through **Z** draw **T A**; make **Z A** equal **Z T**, make the joints **B** and **Z** at right angles to the tangents; through **A M**, **9, 12, 22** and **10** of the convex and **T H K 7, 11** of the concave trace the curved edges of the face-mould. The angle with which to square the wreath-piece at joint is taken by bevel **E**, FIG. 3, and for squaring joint **B** the bevel **X** of FIG. 3.

Fig. 5.—Make **W T** equal four rises. From **A** make **A 6** parallel to **W 14**; make **A B** perpendicular to **A C** and equal to **6 T**; join **B C**. This position of the plan with its tangents and angles of inclination is removed and completed at FIG. 6.

Fig. 6. Plan of Wreath-piece over Four Treads, taken from Fig. 5.—Make **C N** parallel and equal to **A W**; make **6 J** equal to **A B**; make **J H** parallel to **W A** and **H R** parallel to **W 6**; join **R N** and prolong to **M** indefinitely; prolong **6 W** to **M**; parallel to **R N** draw **Z 4**, **K 3** and **A X**; parallel to **W 6** draw **2 F**; parallel to **A B** draw **O Q**; at right angles to **N R** draw **W E** and **C D** indefinitely; on **A** as centre with **A 6** as radius describe the arc **6 E**; again, on **A** as centre with **B C** as radius describe an arc at **D**; join **D E**.

To Find the Angle with which to Square the Wreath-piece at the Joint over W:—Make **W L** equal **J G**; join **L M**: then the bevel at **L** contains the angle sought.

To Find the Angle with which to Square the Wreath-piece at the Joint over C:—Draw **C X** at right angles to **C A**; draw **X Y** at right angles to **X C** and equal to **A V**; join **Y C**: then the bevel at **Y** contains the angle required.

Fig. 7. Face-mould from Plan Fig. 6, Showing also the Squaring of the Wreath-piece at the Joints.—Make **D U E** equal **D U E** of FIG. 6; on **D** as centre with **C B** of FIG. 6 as radius describe an arc at **A**; on **U** as centre with **U A** of FIG. 6 as radius intersect the arc at **A**; join **A E**, **A D** and **U A**; make **D Q** equal **C Q** of FIG. 6; make **A H F** equal **A H F** of FIG. 6; parallel to **U A** through **Q** draw **Z 4**; parallel to **U A** through **H** and **F** draw **P S** and **K 3**; make **Q Z**, **Q 4** and **A T** equal **O 4**, **O Z** and **A T** of FIG. 6; make **H S**, **H P**, **F 3** and **F K** equal **R S**, **R P**, **2, 3** and **2 K** of FIG. 6; through **D** draw **Z B**; make **D B** equal **D Z**; through **E** draw **K C**; make **E C** equal **E K**; through **B 4 A S 3 C** of the convex and **Z T P K** of the concave trace the curved edges of the face-mould. The angle with which to square the wreath-piece at joint **D** is taken by the bevel at **Y**; and for joint **E** by the bevel at **L** of FIG. 6.

Fig. 8. Plan of Wreath-piece, including the First Tread.—To find the height **C O** set up an elevation of the bottom step and two rises as at FIG. 9, let **X** be the centre of baluster and **X O** half the thickness of rail. Make **H Z** equal four inches and **Z L** half the thickness of rail; draw **L C** parallel to the floor-line; the angle at **O** must equal the angle **B** of FIG. 5. Again at FIG. 8 make **C O** equal **C O** of FIG. 9; from **O** parallel to **C B** draw **O L**; from **L** draw **L F** tangent to the centre line of rail at **F**; make **F H** at right angles to **F L**; parallel to **F L** draw **C G**, **U T** and **J R**; parallel to **C O** draw **S P** and **R Q**; at right angles to **F L** draw **C D**, on **L** as centre with **L O** as radius draw the arc **O D**; join **D F**.

To Find the Angle with which to Square the Wreath-piece at the Joint over C:—Make **C K** equal **C P**; join **K E**: then the bevel at **K** contains the angle sought.

To Find the Angle with which to Square the Wreath-piece at the Joint over F:—Make **H G** equal **C O**; join **G F**: then the bevel at **G** contains the angle required.

Fig. 10. Face-mould from Fig. 8, Showing also the Squaring of the Wreath-piece at the Joints.—Let **F D** equal **F D** of FIG 8; on **F** as centre with **F L** of FIG. 8 as radius describe an arc at **L**; on **D** as centre with **O L** of FIG. 8 as radius intersect the arc at **L**; join **F L** and **L D**; make **L X X** equal **L Q P** of FIG. 8; through **X X** and **D** parallel to **F L** draw **X J**, **T U** and **D N**; make **L M**, **X T**, **X U** and **D N** equal **L M**, **S T**, **S U** and **C N** of FIG. 8. Make the joints at right angles to the tangents; make **F S** equal **F J**; through **D** draw **Q P**; make **D P** equal **D U**; through **S M Q U** of the convex and **J T N P** of the concave trace the curved edges of the face-mould. This face-mould will not answer for the top of the flight, because at the top, although including but one tread as at the bottom and setting up the usual height from the floor for the level rail, yet the total height is greater. This will be understood by examining FIG. 11—which is set up for the top—and comparing it with FIG. 9.

FIG. 1.

FIG. 3.

FIG. 5.

FIG. 8.

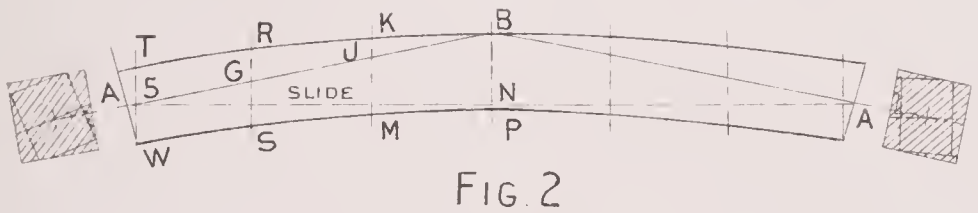


FIG. 2

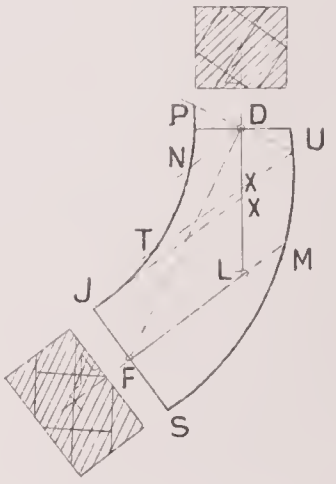


FIG. 10.

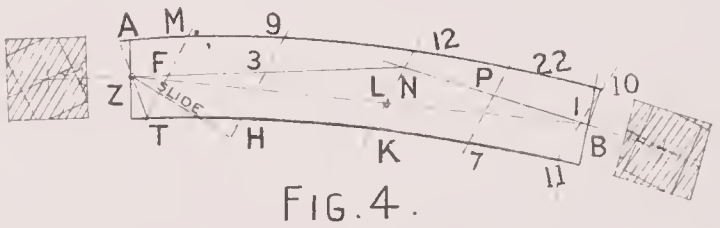


FIG. 4.

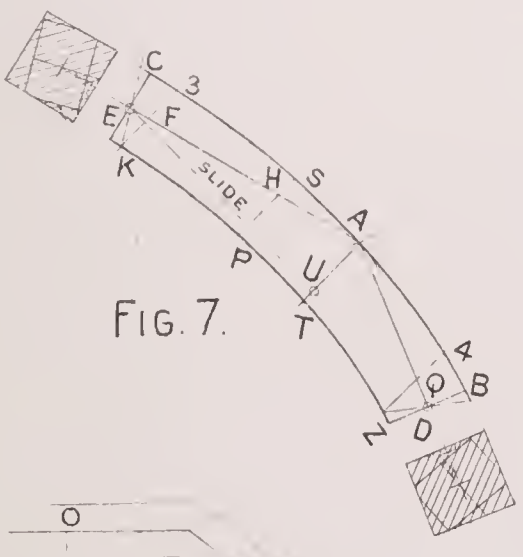


FIG. 7.

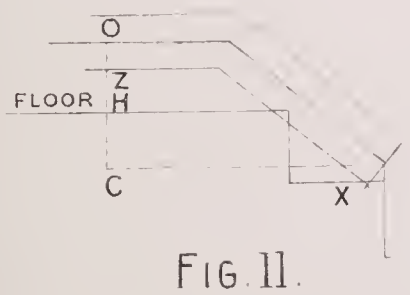


FIG. 11.

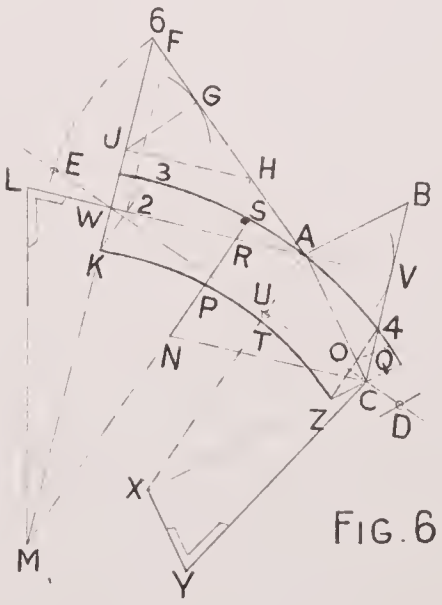


FIG. 6.

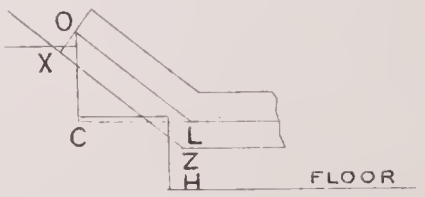


FIG. 9.

SCALE $\frac{1}{2}$ IN = 1 FT

PLATE 56.

Figs. 1 and 2. Wreath-piece from a Face mould, with Tangents at Right Angles, the Position of one of which Tangents B L is Inclined, while that of L D is Horizontal.—The sliding of the face-mould along the joint C D and at F, the other side of the stuff, to plumb the sides of the wreath-piece, is shown by the dotted lines. The sides G H, J K of the wreath-piece at the centre butt-joint are not straight lines. On the concave side of the wreath-piece G H is a concave curve, and J K of the convex a convex curve on that side. This is true also of all wreath-pieces having butt-joints falling within a circular plan, but these straight sides are corrected in the hands of a skilful rail-worker, who, leaving some over-wood—after the two pieces are bolted together—works the sides plumb with the proper-shaped tools FIG. 2 shows the wreath-piece with the concave side cut away plumb. When this side is worked plumb, a gauge, like FIG. 8, having an arm provided with a large pencil, may be used to mark the width on the convex side; next the top is shaped, and from this the thickness is gauged. The directions here given with regard to this wreath-piece apply generally to all, but particularly to the following:

Plate 24, Fig. 3,	Plate 25, Fig. 6,	Plate 26, Fig. 6,	Plate 27, Fig. 6,
" 32, " 3,	" 37, " 4,	" 40, " 6,	" 43, " 3,
" 44, " 5,	" 46, " 3,	" 54, " 3.	

Figs. 3 and 4. Squaring a Wreath-piece from a Face-mould, both Tangents of which are Inclined either on a Common Inclination or on Different Inclinations.—The angle with which to square a wreath-piece at the butt-joint is the inclination of the face of the plank along the joint given by the face-mould, in connection with a line on the joint—which is square through the plank—that coincides with a vertical plane; hence it is commonly understood as an angle giving a plumb-line on a butt-joint

To Determine the Direction in which to Apply the Angles for Squaring a Wreath-piece at the Joints:—Place the lower end of the wreath-piece towards you, turn the upper end to the right or left to suit the hand of the stairs, then move the face-mould up a few inches on the slide-line as at FIG. 3, and it will be seen that as the centre of the joint J is carried toward K, the plumb-line must apply in the direction K M passing through the centre L, and at the upper end the other tangent will be moved towards N, showing that the plumb-line on that joint must lie in the direction N P, passing through the centre O. *The plank edge* A D, *bevels* U *and* V, *show at once the correct position of bevels.*

Another Way of Deciding the Direction in which to Apply Plumb-lines on Butt-joints is as Follows:—Holding the wreath-piece as before directed, cant it up on the corner F—a position it must take—when it will be at once evident that the plumb-line must apply in the direction K M. This causes the stock of the bevel to lay towards the convex; then at the upper joint reverse the stock of the bevel, placing it towards the concave as shown; also the slide-line need not be used, but the tangent line K J (squared from the joint at K) and the face-mould tangent moved on this line until it reaches the point S and N of the upper end.

To Put the Face-mould in Position on the Planes of the Plank so that its Edges will Mark the Plumb Sides of the Wreath-piece:—Hold the wreath-piece as before explained; square a line from the joint at K, K J indefinitely; slide the face-mould up from the lower end along the slide-line until J—the centre of the face-mould joint—falls on the line K J, K being a point at the face of the plank of the previously-applied plumb bevel K M; then again when the face-mould is in this position its tangent at the upper end will touch the point N of the plumb-line N P on the upper joint; also the concave edge of the face-mould will touch S of the plumb-line S T. Apply the face-mould to the other side of the wreath-piece on the slide-line, keeping the joint J of the face-mould as much below the joint of the wreath-piece as it is above it on this side.

Fig. 4. The Wreath-piece Shown with the Concave Side Cut Away Plumb.—In all face-moulds of this character, where a level line passes through the centre from which the plan of the rail is described—the minor axis—there is a place where the plane of the plank is level, and this point on the width X Y and through the thickness X T is the normal place in a wreath-piece, and where the over-wood is removed equally parallel to the faces of the plank. In shaping the wreath-piece the centre line of the thickness of rail will correctly touch R and U, the centre at the joints, and S the centre of the plank. When the face-mould is in position to plumb the sides of the wreath-piece, if the normal place is marked at V and W, the plumb-line V W will pass through the centre of stuff at S, and give the direction in which to move the round-faced plane in working the sides of the wreath-piece plumb. In gauging the wreath-piece to a width, the long arm of the gauge should be held in the direction of the plumb-line W V. *The instruction given under the head of* FIGS. 3 *and* 4 *apply particularly to the following:*

Plate 25, Fig. 4,	Plate 26, Fig. 6,	Plate 27, Fig. 4,	Plate 28, Fig. 4,	Plate 29, Fig. 4,
" 31, " 2 and 4,	" 36, " 3,	" 37, " 7,	" 38, " 4,	" 39, " 4,
" 40, " 3,	" 41, " 4,	" 42, " 4 and 6,	" 43, " 5,	" 44, " 4,
" 46, " 5,	" 47, " 4,	" 50, " 6,	" 51, " 3 and 5,	" 52, " 4,
" 53, " 6,	" 55, " 2, 4 and 7.			

Fig. 5. Wreath-piece from a Face-mould over a Plan of Less than a Quarter-circle, the Position of A K, one of the Tangents, being Level, the other, K Z, Inclined.—The dotted lines show the face-mould as placed at the joint D to plumb the sides of the wreath;* the tangent A of the face-mould is brought to C on the other side of the wreath-piece. The sliding of face-moulds of this character is always along the joint, which is at right angles to the level tangent, the same as FIG. 1. The above instructions apply particularly to the following:

Plate 24, Fig. 6,	Plate 30, Fig. 2 and 4,	Plate 32, Fig. 6,	Plate 33, Fig. 3,	Plate 48, Fig. 4,
" 49, " 3,	" 50, " 5 and 7,	" 53, " 5 and 7,	" 55, " 10.	

Figs. 6 and 7. How to Determine the Least Thickness and Width of Wood Required for any Wreath-piece of any Form of Rail.—From the centre of the thickness and width of the proposed form of rail describe a circle enclosing the form; then the diameter of such a circle will be both the least thickness of the plank, and also the least width of the wreath-piece out of which the twist can be worked.

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* *At* FIG. 5 *and the list given in the application of the angles to square wreath-pieces at the joints, the stock of the bevel at both joints lies towards the convex side of the wreath-piece as shown.*

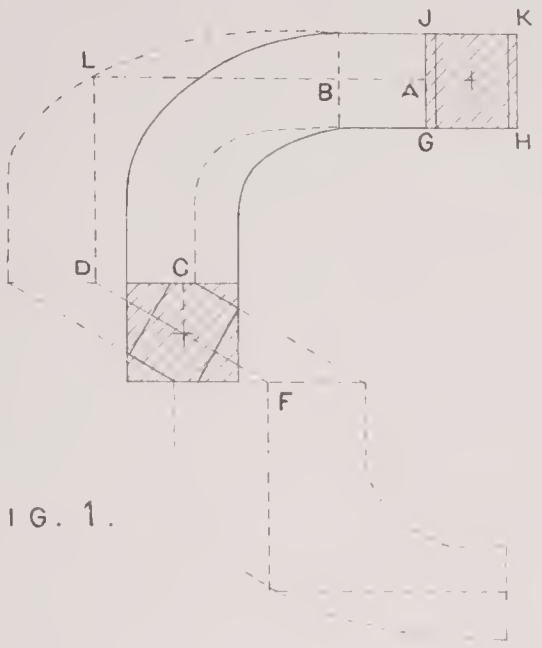


FIG. 1.

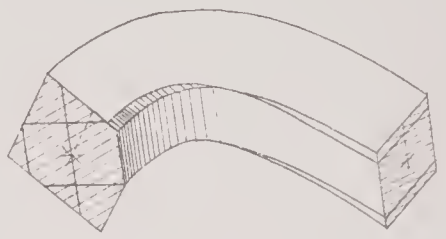
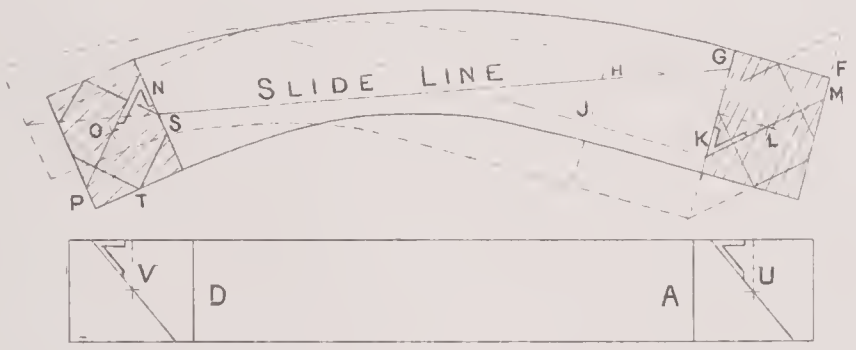


FIG. 2.

FIG 3



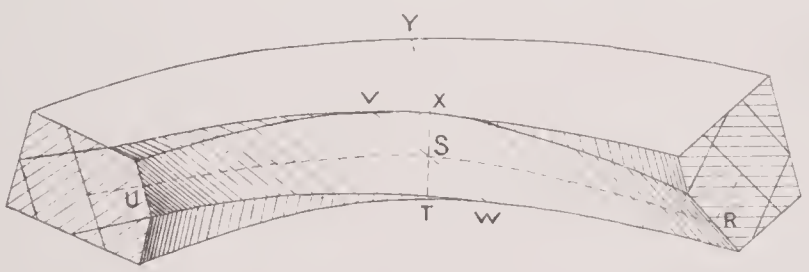


FIG. 4.

FIG. 5.

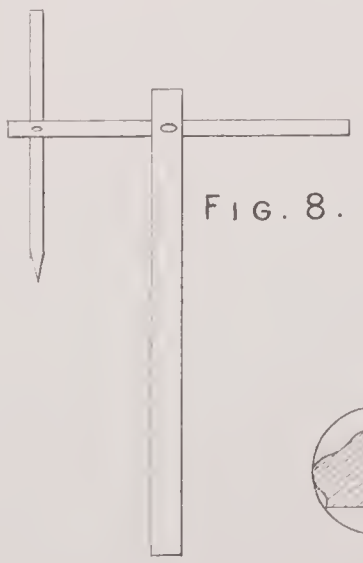


FIG. 8.

FIG. 6.

FIG. 7.

PLATE 57.

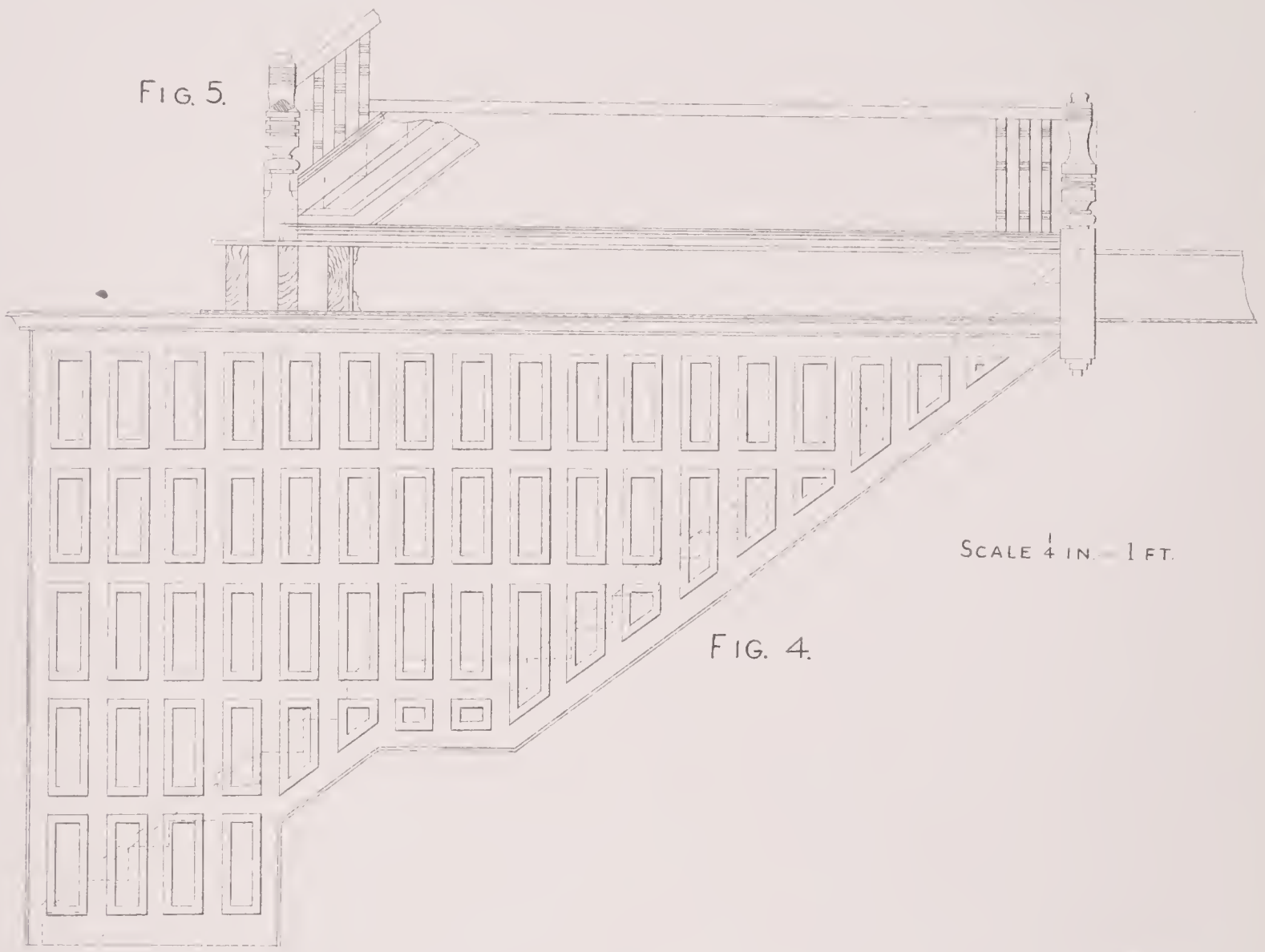
Fig. 1. Plan of Stairs Suitable for Wholesale Stores.—These stairs from the first to the second story are enclosed with panel-work as shown by the elevation FIG. 4. The door to shut off communication between the two stories is often placed on the platform, and in that case the platform is so situated that the door trims under the end of the well-hole. Side-rails are hung on strong ornamental iron brackets, sometimes on both sides of wide flights. The newel-posts are never less than seven inches. and those at the top of the flights are continued below the ceiling, finishing at the lower end with turned work.

Fig. 2. Construction of Close String Paneled.—This finish of string is used in the upper flights that are furnished with hand-rail and balusters, as at FIG. 5 The well-holes of each story are framed shorter than the run of the flights above, so that each flight starts from the floor below, resting directly on the floor-beams.

Fig 3. Panel-work.—By this plan the middle muntins A are wider than the face-muntins D, so that the mouldings may be nailed free from the panels, allowing the latter to shrink without disturbing the mouldings.

FIG. 1.

FIG. 5.



SCALE $\frac{1}{4}$ IN. = 1 FT.

FIG. 4.

FIG. 3.

SCALE $1\frac{1}{2}$ IN = 1 FT.

FIG. 2.

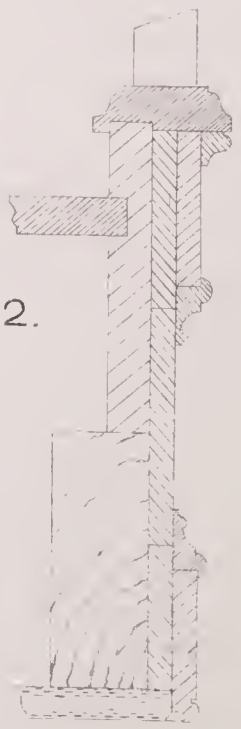


PLATE 58.

Fig. 1. Plan of the Landing Portion of a Staircase with Square Corner-pieces like Small Low-down Newels set in the Angles with a Continued Hand-rail Over.—This plan is given at PLATE No. 6, FIG. 6 L and M are $3\frac{1}{2}''$ square angle-pieces that are brought above the platform and floor as shown in connection with the elevations FIGS 3 and 4. The centres of balusters A and B are equal in distance to A and Q. The square angle at the corner-piece L is turned for the continued hand-rail one quarter C D V, C R S, using only $\frac{1}{2}''$ radius from the face of the corner-piece E to D, then from the joint D R of the level quarter another $\frac{1}{2}''$ is taken at the ramp to ease over to this level, as shown at the elevation FIG 3, Z X and X K.

Fig. 2. Design and Construction of Close Front-string.—The drawing to the scale given will be a sufficient explanation

Figs. 3 and 4. Elevation of Treads and Rises, including the Square Corner-piece Connecting with the Platform, the String and the Level as given at Plan Fig. 1.—O P equals O P of FIG. 1. The face P E of the corner-piece L, FIG. 1, is along the line P E Z; Z X equals D E of FIG. 1; Z K equals one inch; the joint J H connects with D R of FIG 1 The height to the bottom of rail Y from the step at the line of rise W is 2'.1". The height from floor to bottom of level rail S J is 2'.6". C D, V V is the carriage-timber, showing its bearing against the front platform-timber at V V. F, N and T are places of mortices to receive the tenons of string. The baluster at B is intended to be set three eighths of an inch into the mill-plowed hand-rail, as shown at the section A, and then pieces set between each baluster, $\frac{1}{4}''$ thick, thus leaving a finished panel or sinkage of $\frac{1}{8}''$, the depth of which gives a much better appearance to the bottom of the rail than when flush.

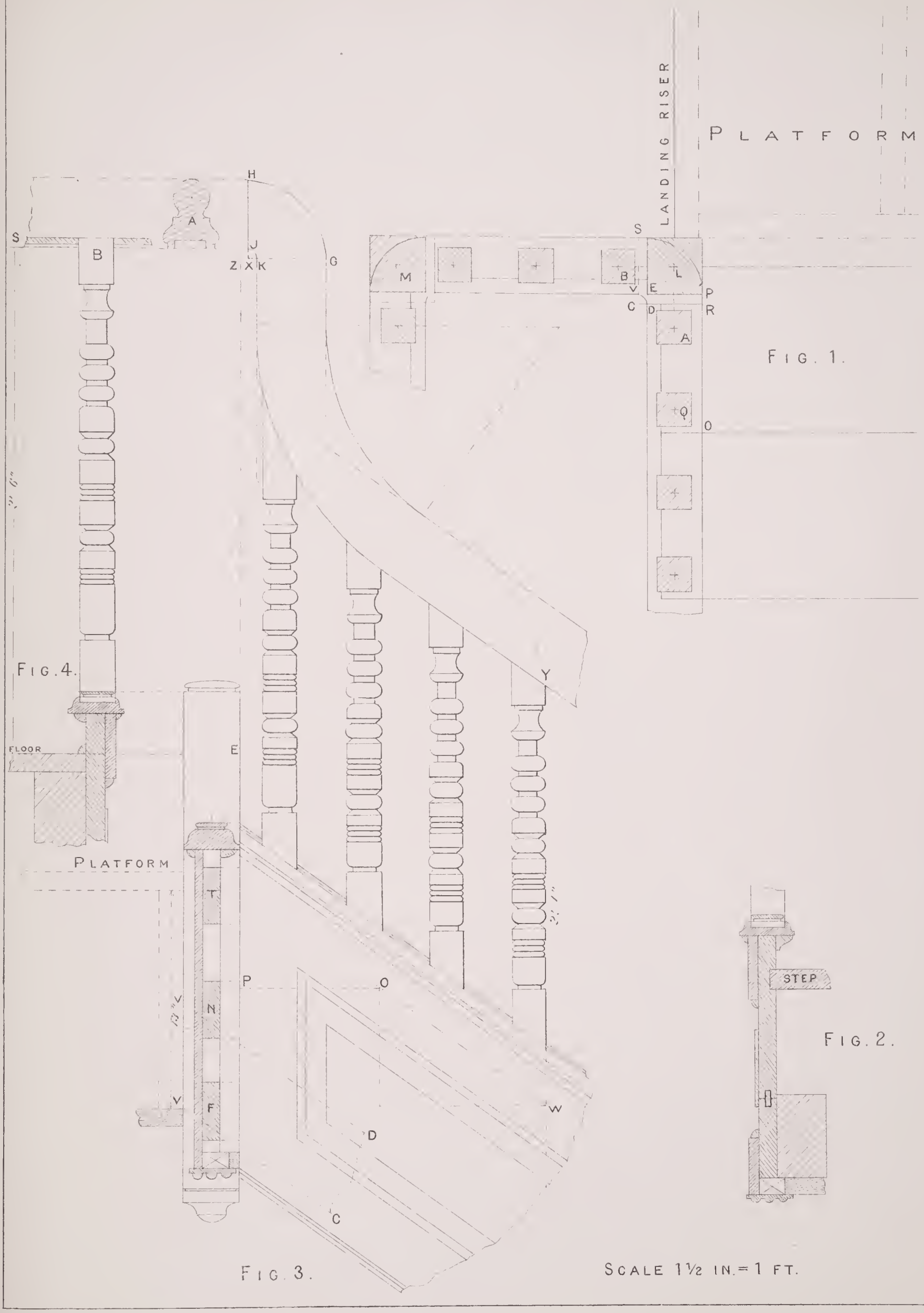


FIG. 1.

FIG. 4.

FIG. 3.

FIG. 2.

SCALE 1½ IN. = 1 FT.

PLATE 59.

Fig. 1. Plan of the Upper Portion of a Quarter Platform Staircase with Square-moulded Newels set in the Angles.—This plan is given at PLATE No. 7, FIG. 5. The dotted lines show a portion of the rough framing of the platform.

Fig. 2. Design Elevation and Details of Plan Fig. 1.—Through this elevation the lengths of the angle newels and the connections of hand-rail, balustrade work, strings, etc., are obtained. The face of the newel marked A at the lower end showing its connections is face A at plan FIG. 1; also the face of the newel marked E at the lower end is face E at plan FIG. 1.

Fig. 3. Laying Out the Newel connected with the Platform, the Sides of which are Lettered on the Plan Fig. 1, A B C D.—The four faces of this newel are lettered at the top to correspond with the plan FIG. 1. J K is the total length of the newel-shaft as taken from J K of the elevation FIG. 2. The distances marked by the letters J L M N indicate principal points of measurement taken from the corresponding letters of the A side of newel, FIG. 2; and the same may be said of the letters O P Q at face D; the sides B and C will be understood by comparing them with their adjoining sides and connections, and B and C of FIG. 1.

Fig. 4. Laying out the Landing Newel the Sides of which are Lettered on the Plan Fig. 1, E F G H.—The letters at the top of these sides correspond with those of the plan FIG. 1. R S of the side E marks the total length of this newel-shaft, and T U V the principal points of measurement lettered the same at FIG. 2. W X Y of the connection at the side F are also the principal points of measurement taken from the elevation of the landing newel, FIG. 2. The sides H and G will be understood by examining them in connection with the adjoining sides and G and H of FIG. 1.

Fig. 5. Balustrade Moulding as Shown in Place at the Elevation Fig. 2.

Fig. 6. Construction of Square Newel-posts.—The narrow pieces forming the sides A and B of the newel-shaft should have blocks glued to the inside faces at the edges—not more than one foot apart—when the glue is set to be jointed with the edges square from the face; also to guard against the joints giving way, hard-wood dowels ought to be set in as shown at suitable intervals. *The sides of the newel-shaft would be better if put together with good mitre-joints blocked and dowelled as before.*

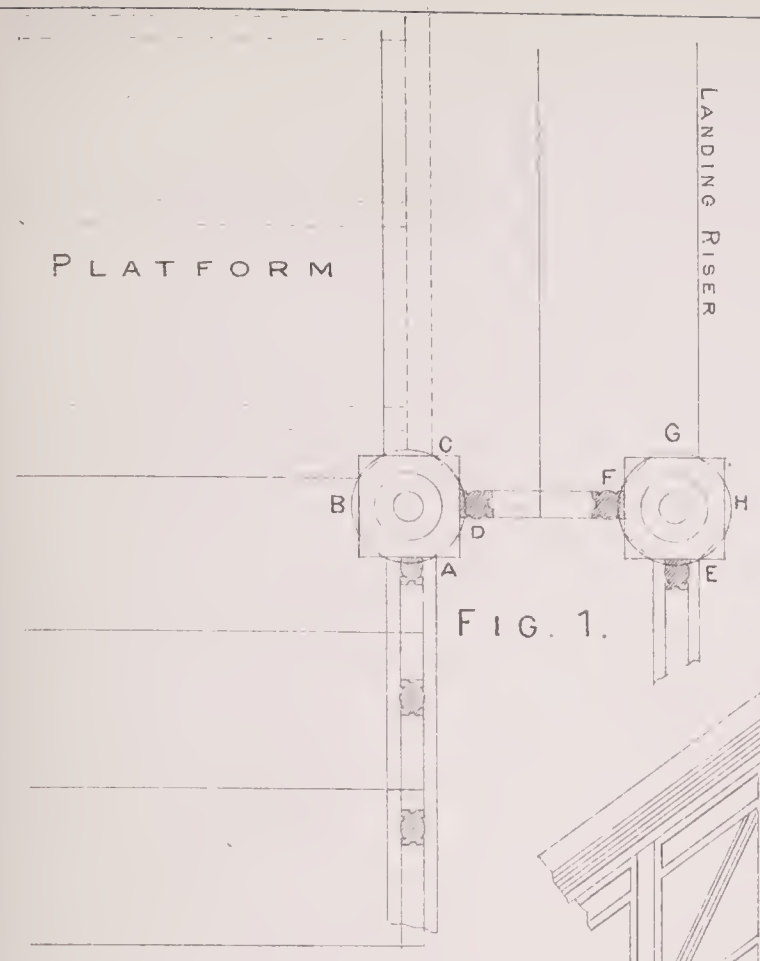


FIG. 1.

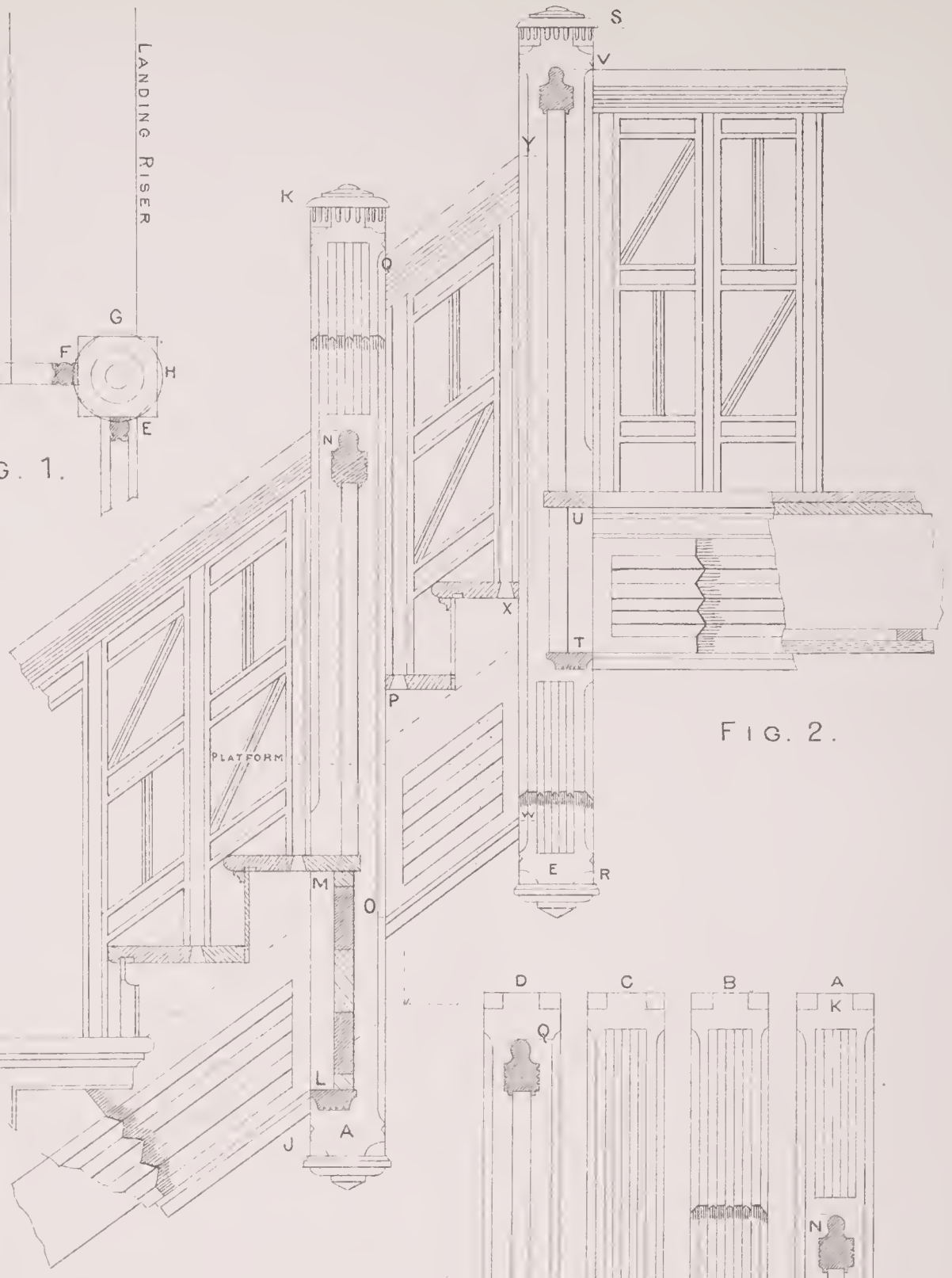


FIG. 2.

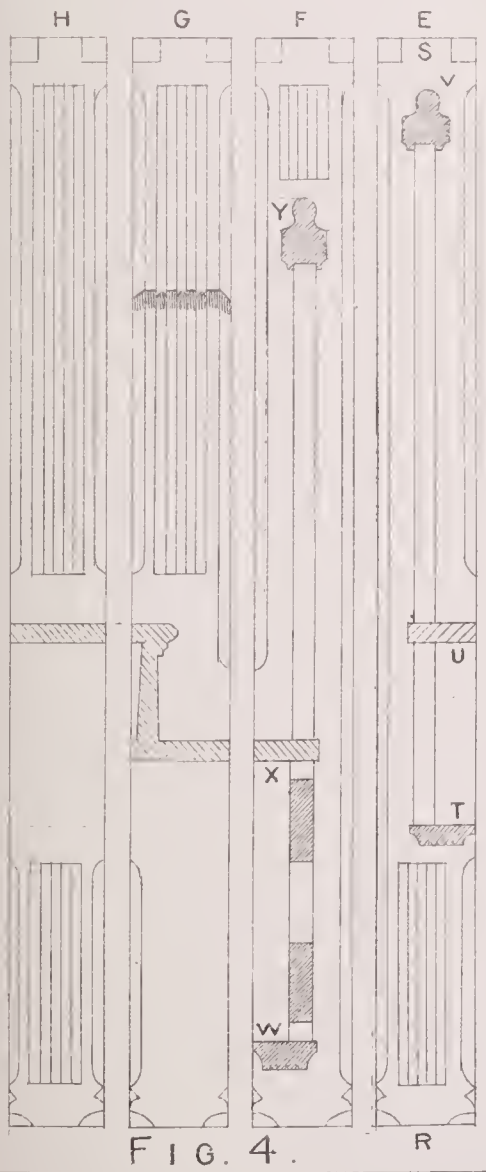


FIG. 4.

FIG. 5.

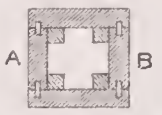


FIG. 6.

SCALE 3/4 IN. = 1 FT.

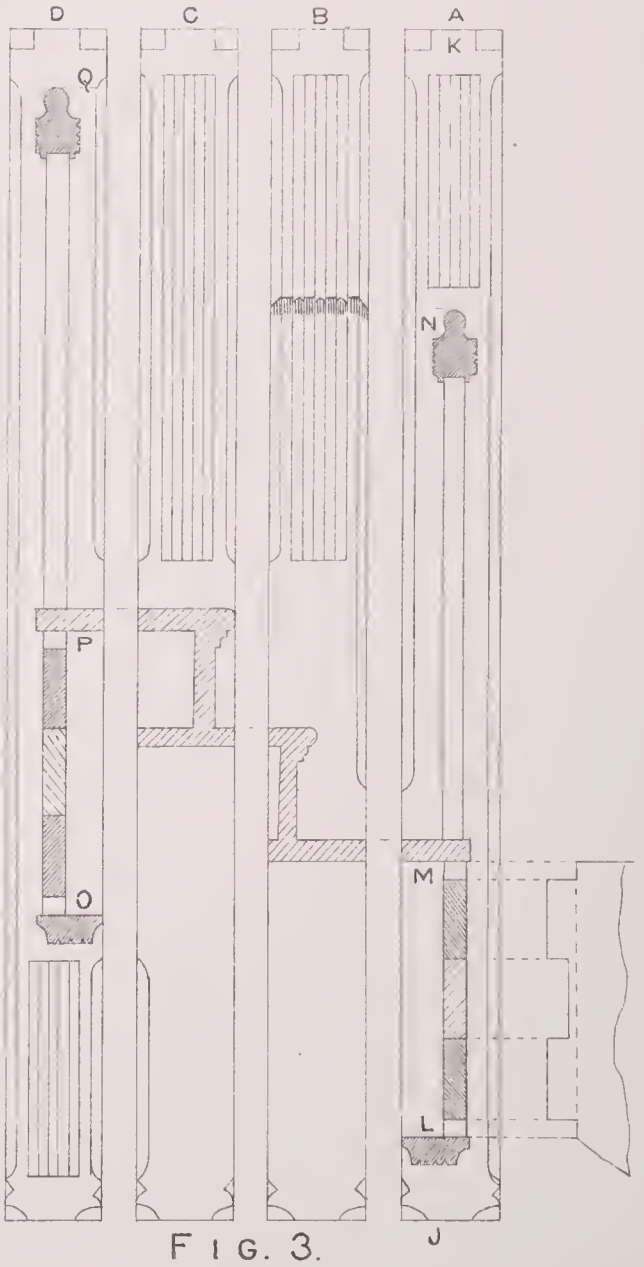
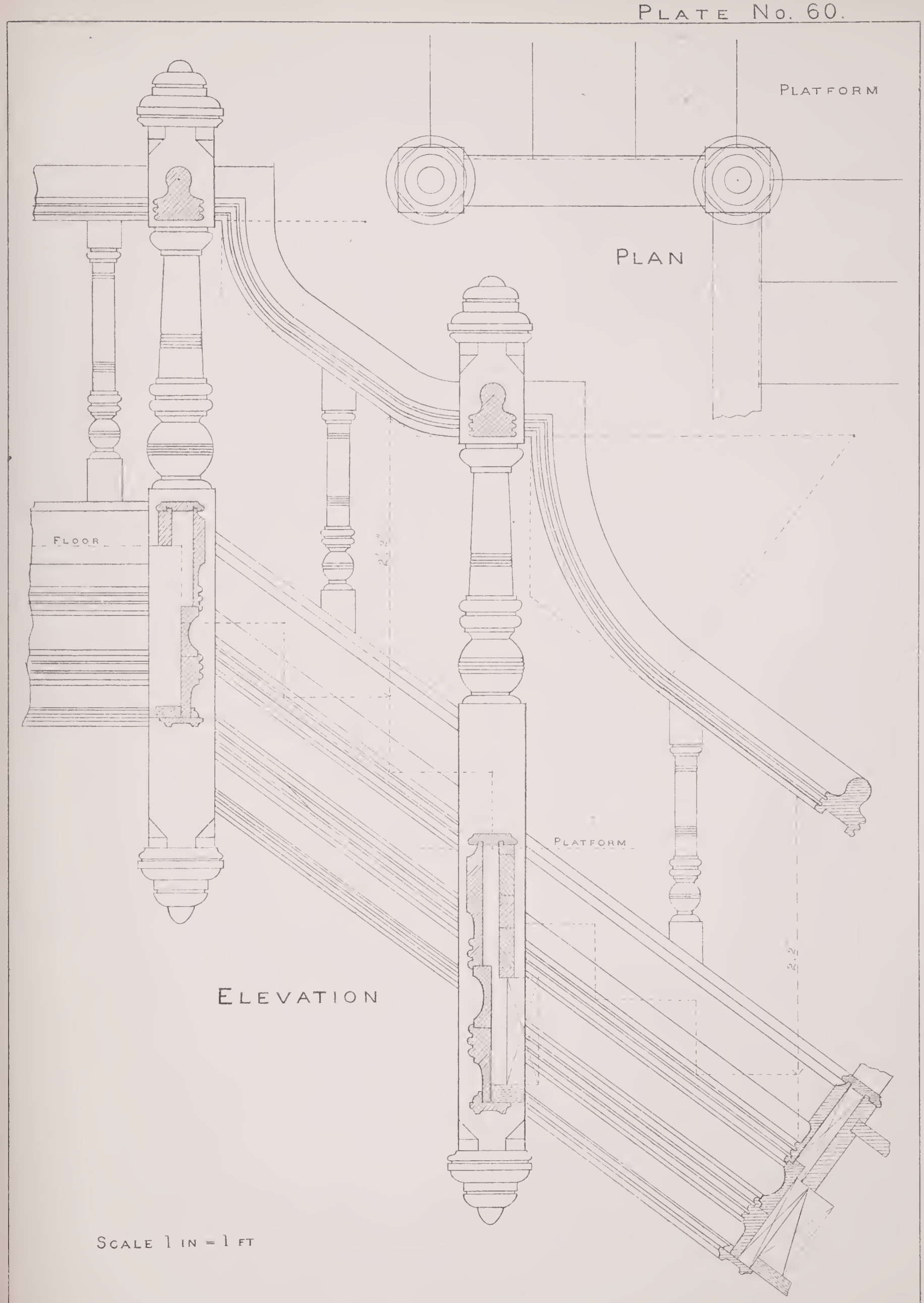


FIG. 3.

PLATE 60.

Plan and Side Elevation of a Quarter-turn Open Newel Platform Stairs.—Design and construction for moulded close front-string, turned newel and balusters; the hand-rail with ramp and knee.

PLATE No. 60.



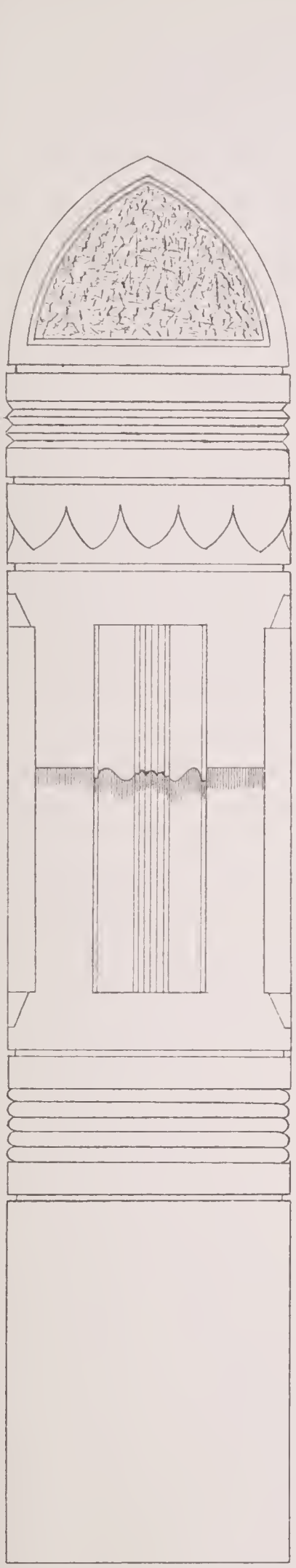
ELEVATION

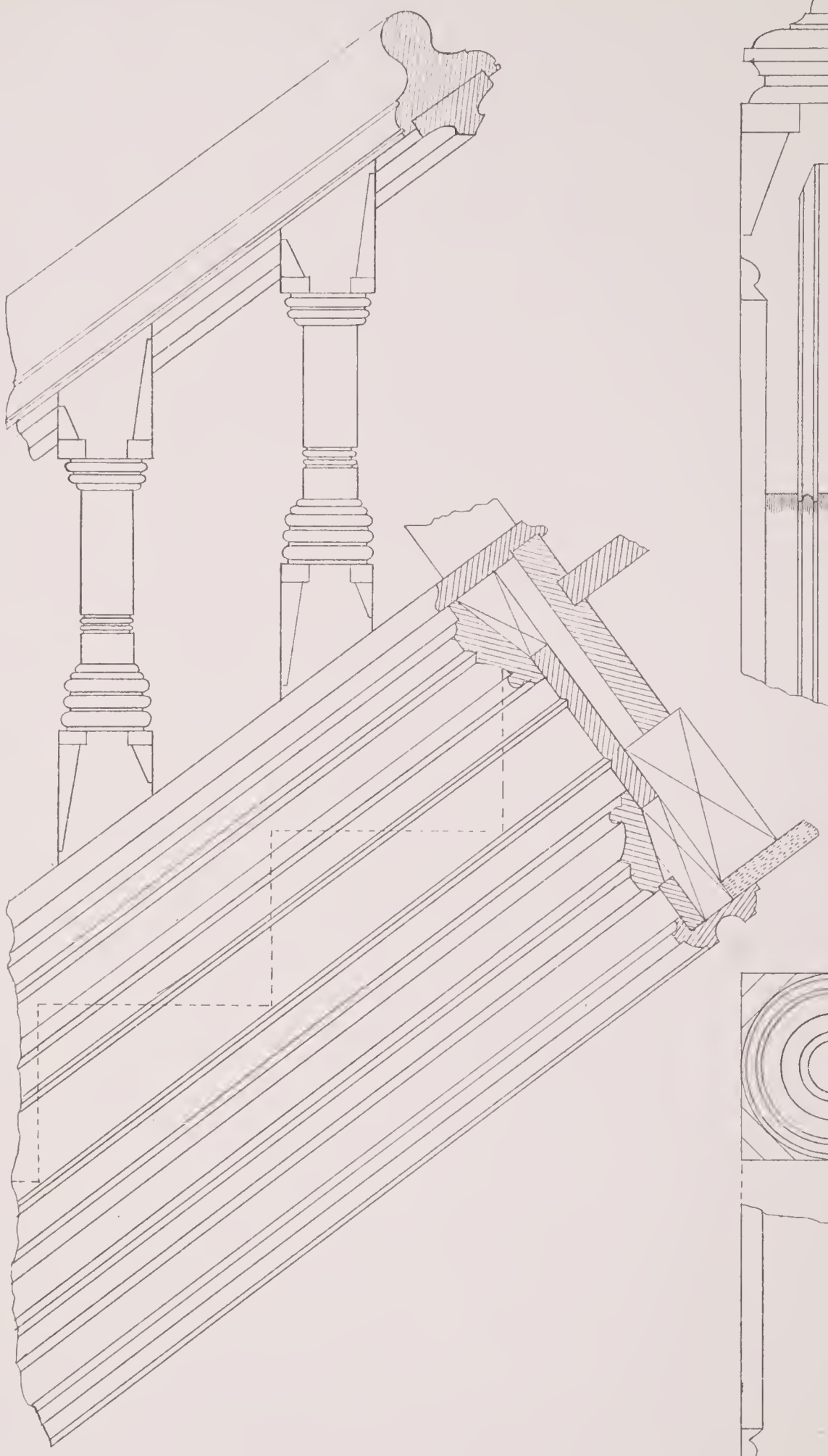
SCALE 1 IN = 1 FT

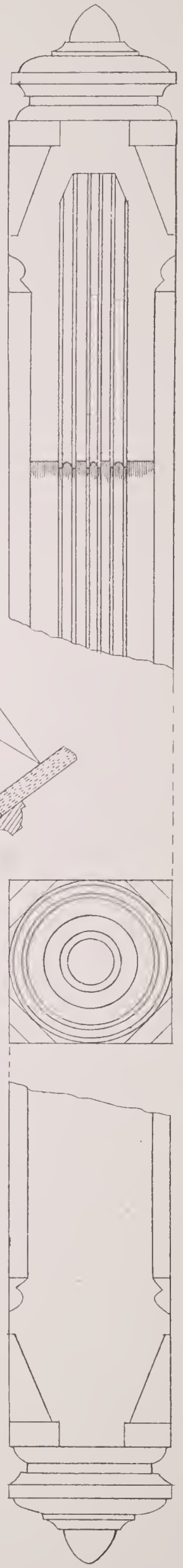
PLATE 61.

Design for Newels, Turned Balusters, and Close Front-string.

PLATE No. 61.





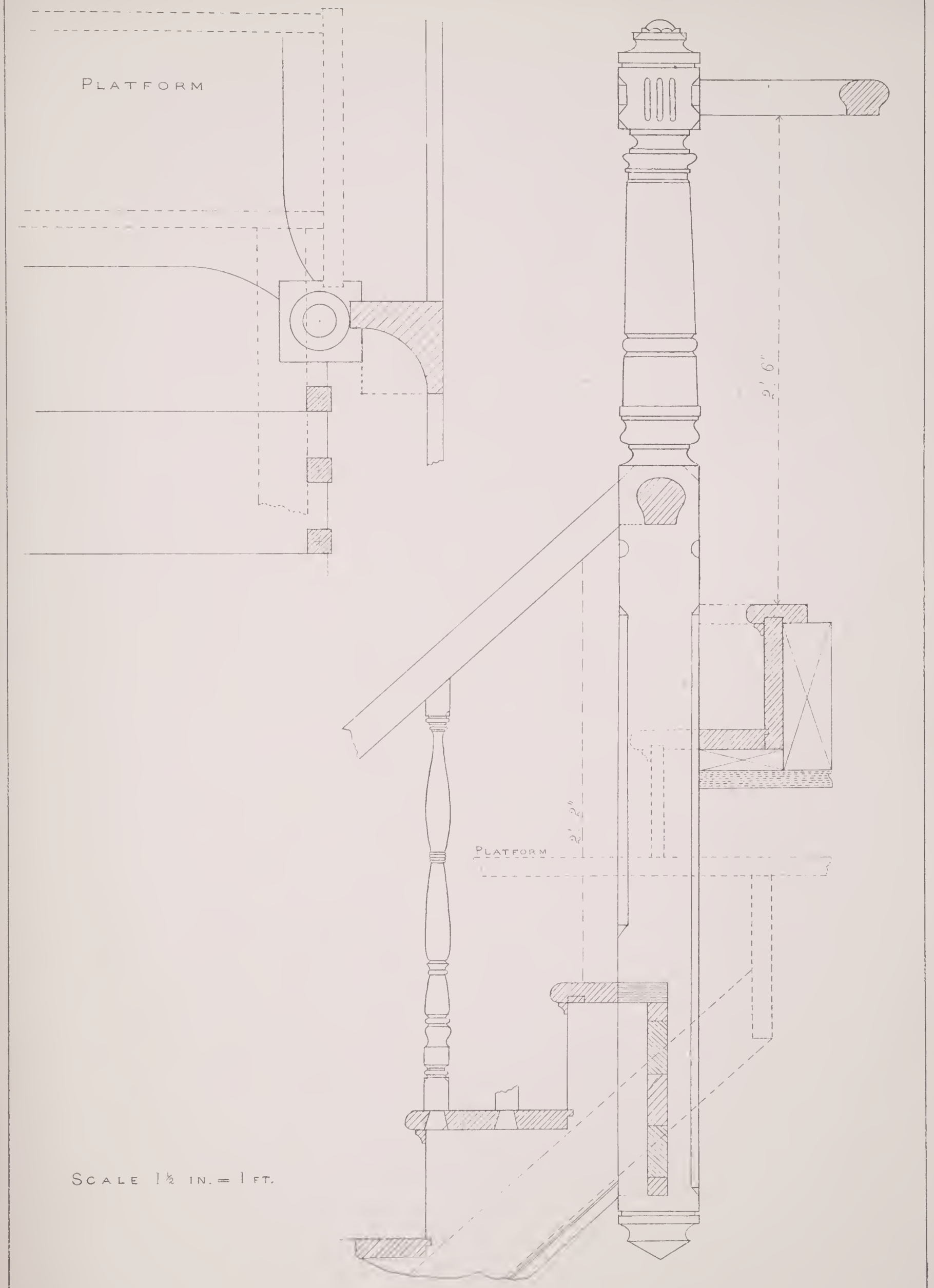


SCALE 1½ IN. = 1 FT.

PLATE 62.

Plan of Stairs Turning One Quarter, with Platform and Two Risers Curved at their Front Ends to Newel.—The plan is designed to dispense with winders and give a comfortable, easy stairs for travel, taking but a few inches more room than the usual winders that are required to make a quarter-turn. The small newel receives the straight rail of the flight and the level hand-rail at the landing, as shown by the side elevation. This arrangement requires no twists or easements; the only turn of the hand-rail is the level quarter. See PLATE 5. FIG. 7.

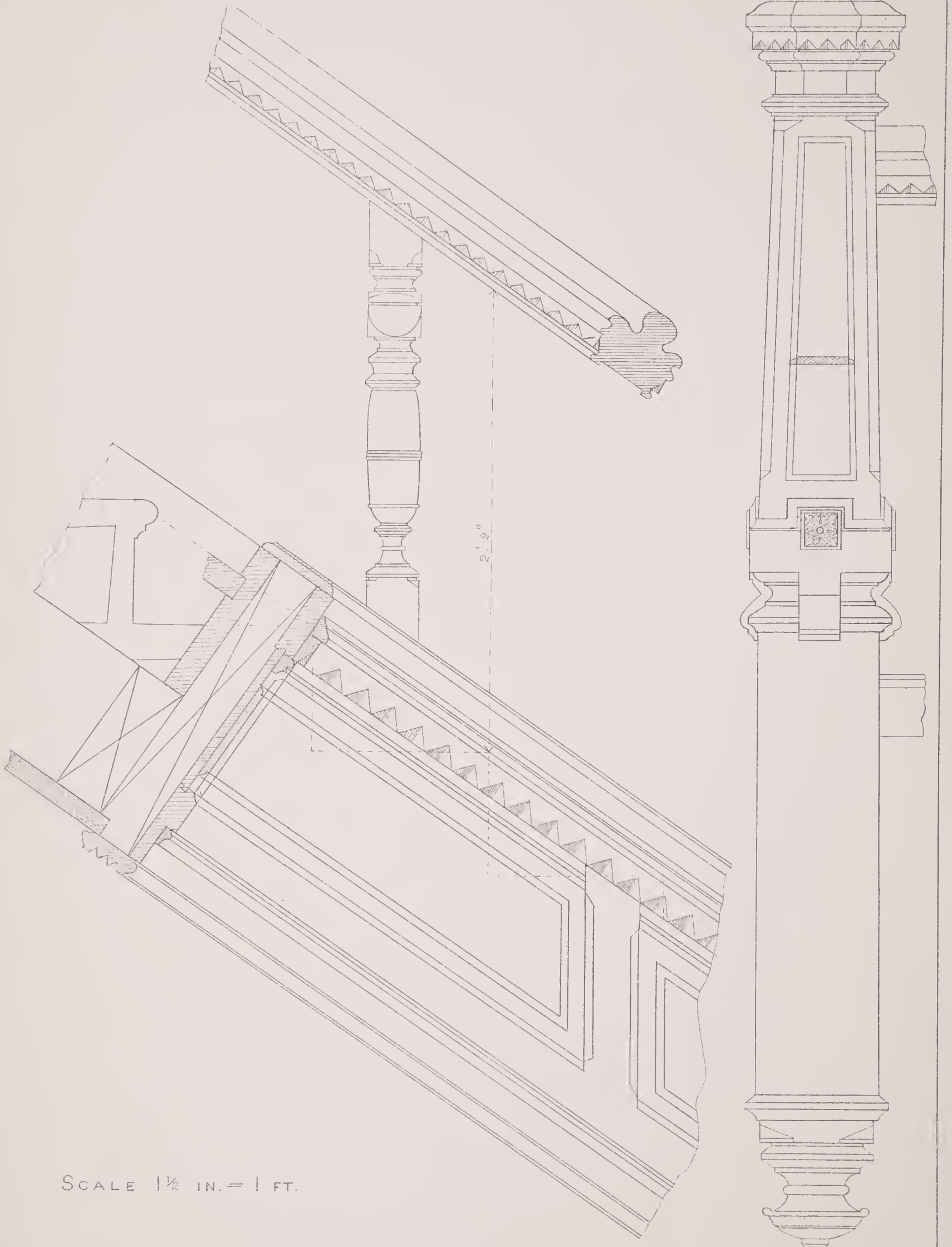
PLATE No. 62.



SCALE 1½ IN. = 1 FT.

PLATE 63.

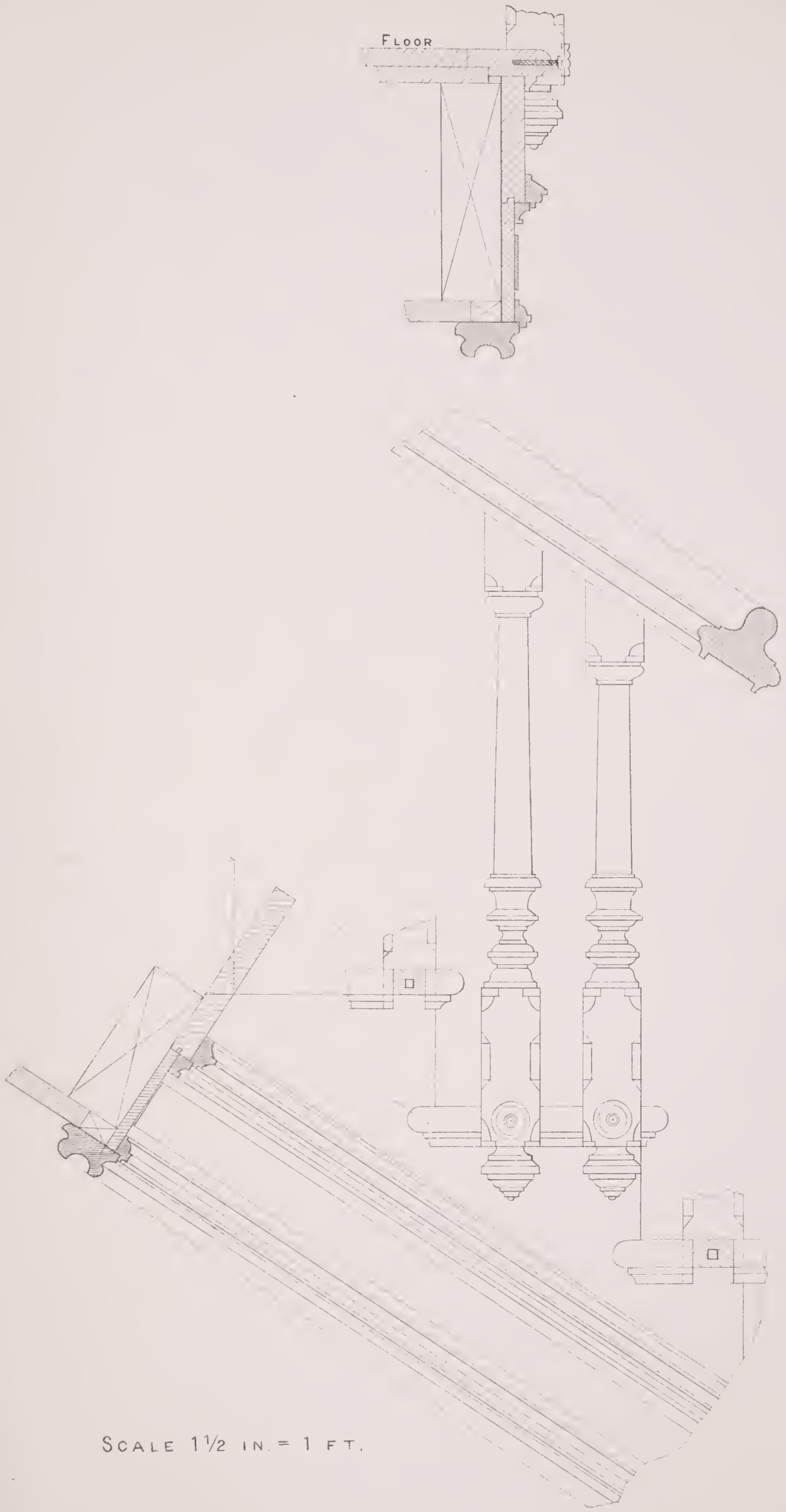
Design for Angle Newel and Turned Baluster, with Square Base and Top; also Design and Construction of Close Front-string Paneled and Moulded.



SCALE 1½ IN. = 1 FT.

PLATE 64.

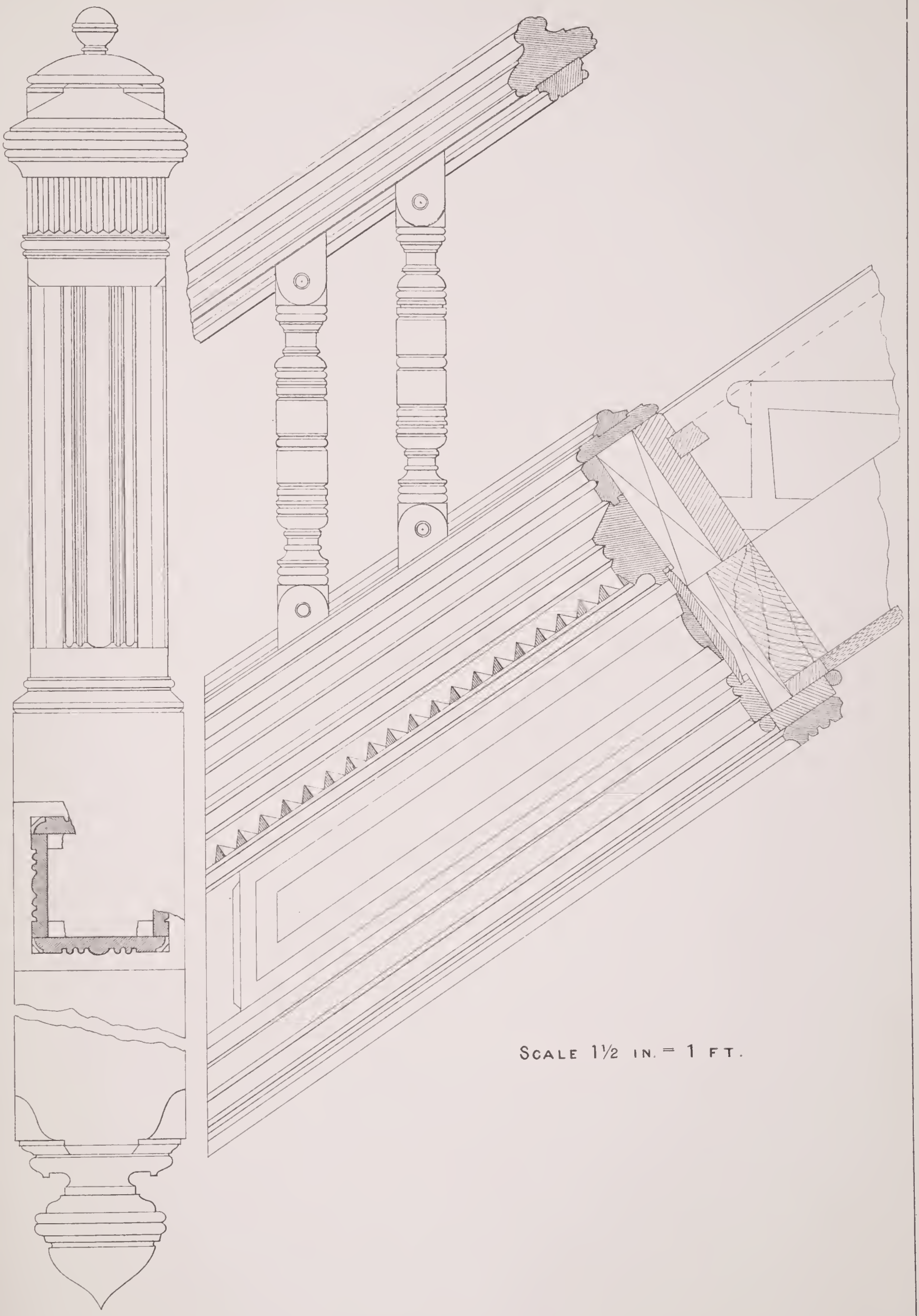
Design for Open Moulded Front-string and Balusters.—The balusters to be bolted to the face of the string.



SCALE 1½ IN. = 1 FT.

PLATE 65.

Design for Angle Newel, and Turned Balusters with Square Tops and Bases; also Design and Construction of Close Front-string Paneled and Moulded.



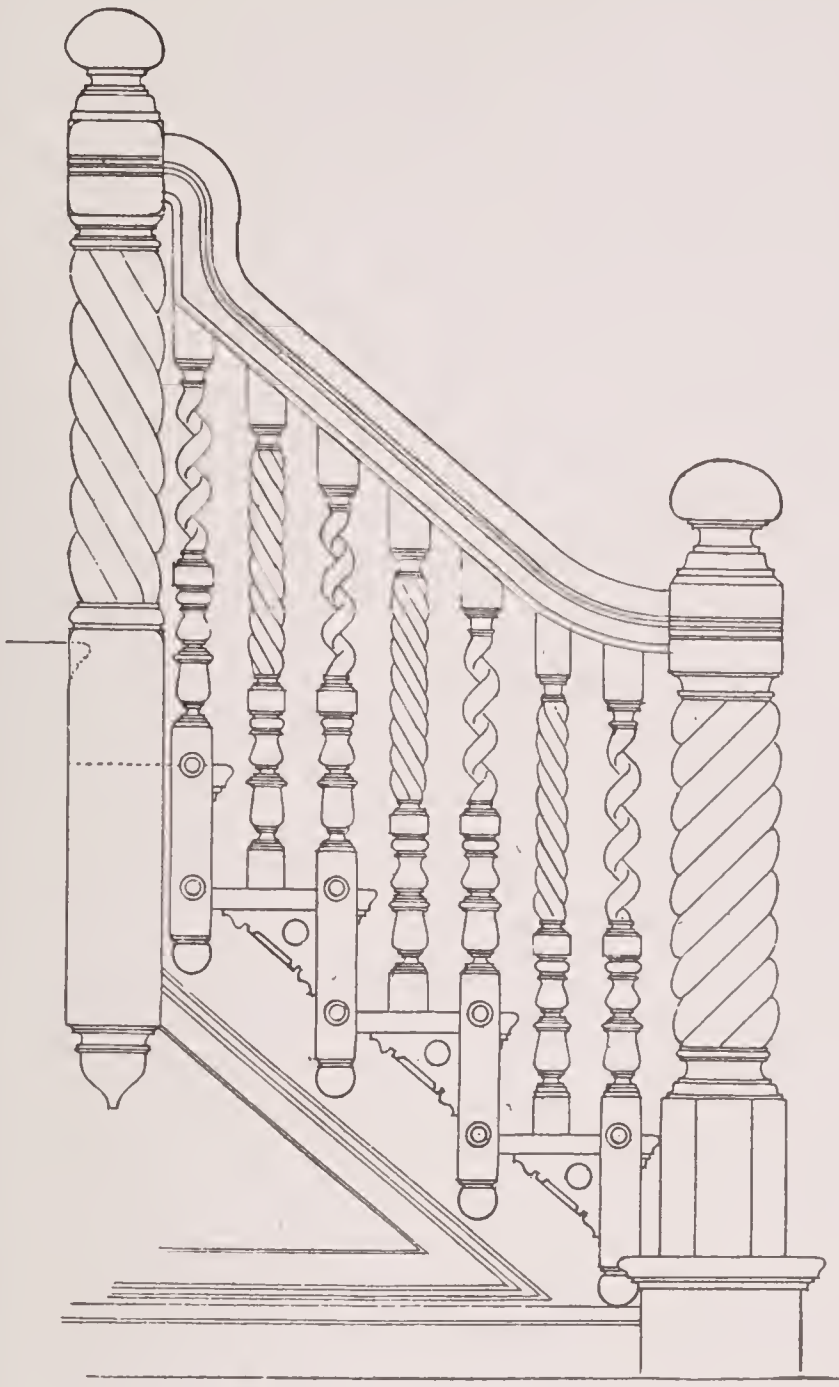
SCALE 1½ IN. = 1 FT.

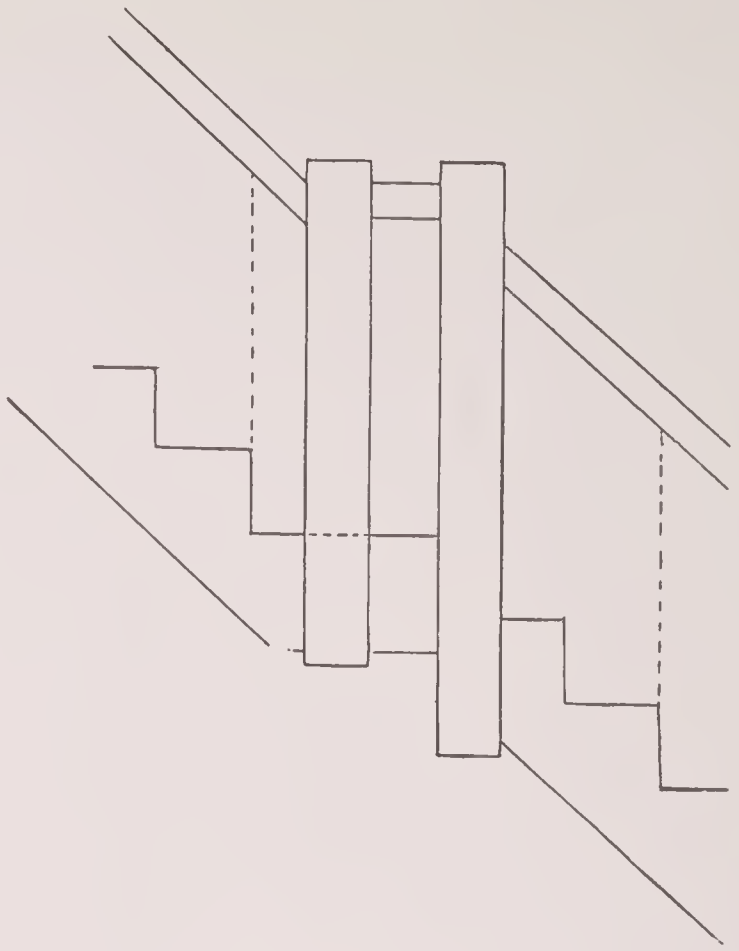
PLATE 66.

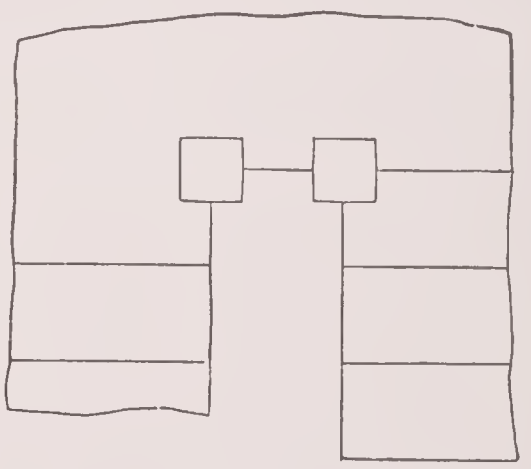
Fig. 1. Design for a Turned and Carved Newel, Carved String and Balustrade.

Fig. 2. Design for Spiral, Turned Newels and Balusters; Bracketed String; Hand-rail with Ramp and Goose-neck.

Figs. 3 and 4.—The bottom riser of the upper flight is set one tread from the centre of newel, as shown on the plan FIG. 3, and the elevation FIG. 4. If, on the contrary, the bottom riser referred to should be placed at the centre of the newel it would then be necessary to make that newel one rise higher from the platform to receive the hand-rail of the upper flight. This difference in the heights of the two newels from the same platform is objected to by some, hence these sketches and explanations.







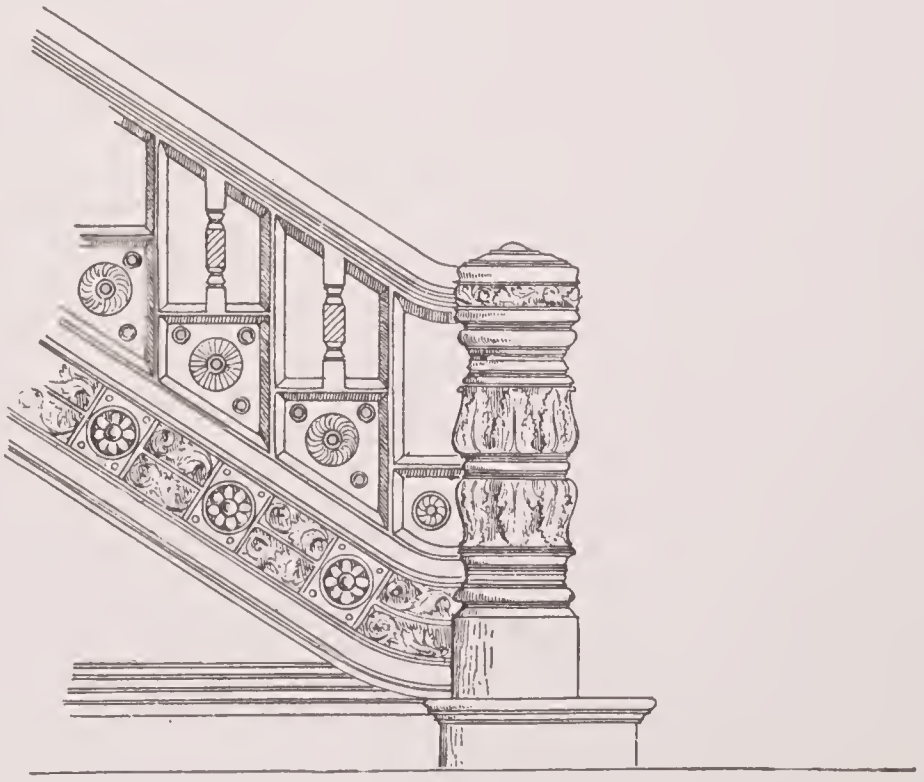


PLATE 67.

Ancient Staircase at Rouen, France.—From the *Moniteur des Architectes.* "*American Architect and Building News.*"

STAIRCASE ROUEN FROM THE MONITEUR DES ARCHITECTES

PLATE 68.

Interior View of a Flight of Stairs Turning One Quarter, with a Platform at the Starting Two Rises Up; the Platform Ornamentally Enclosed on One Side with Fancy Panel-work to Match the Hall Wainscot; and Above which and Across the Hall, Spindle Screen Panels between Columns.

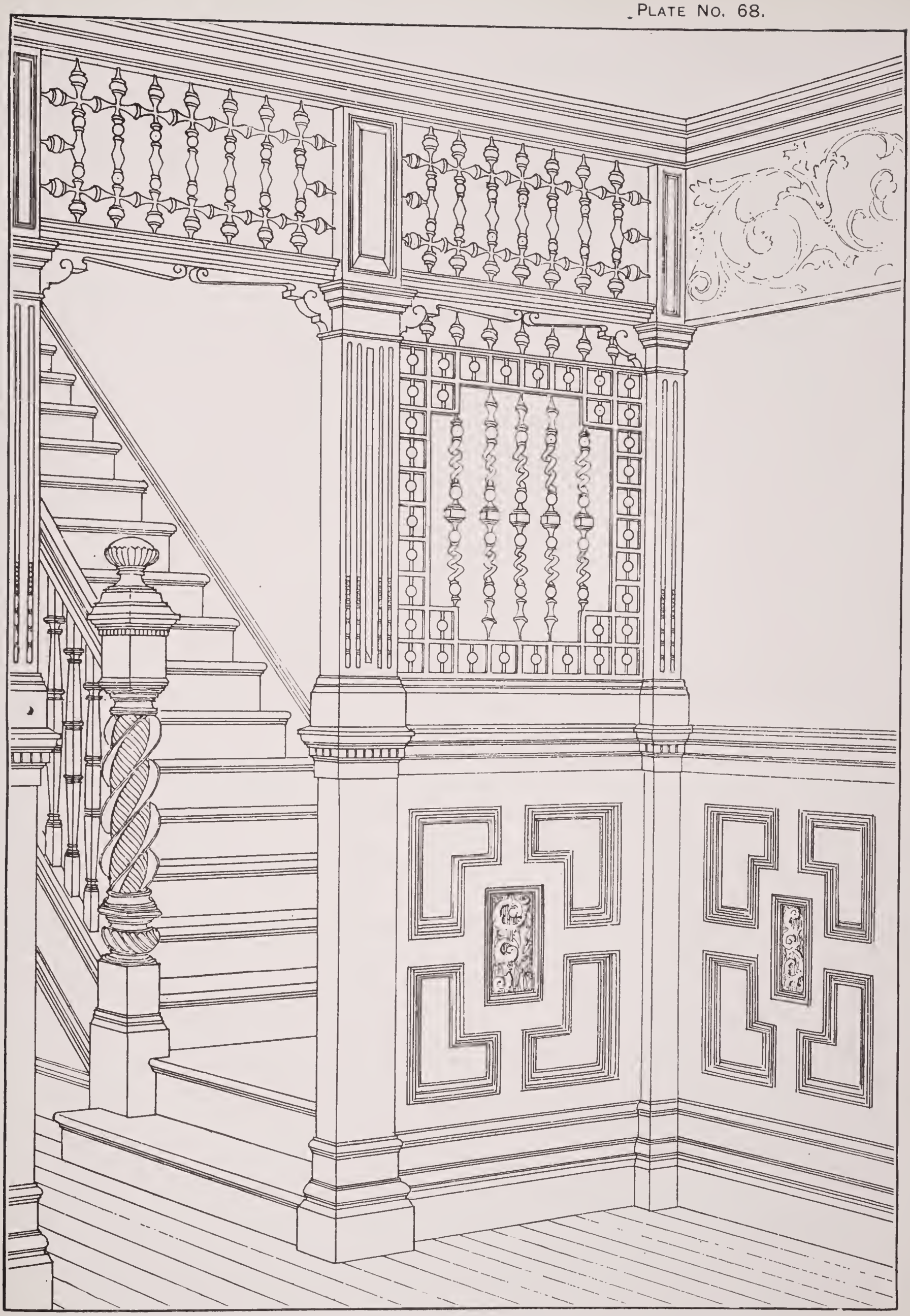


PLATE 69.

Interior View of a Grand Staircase, and Spacious, Elegantly Fitted Hall.

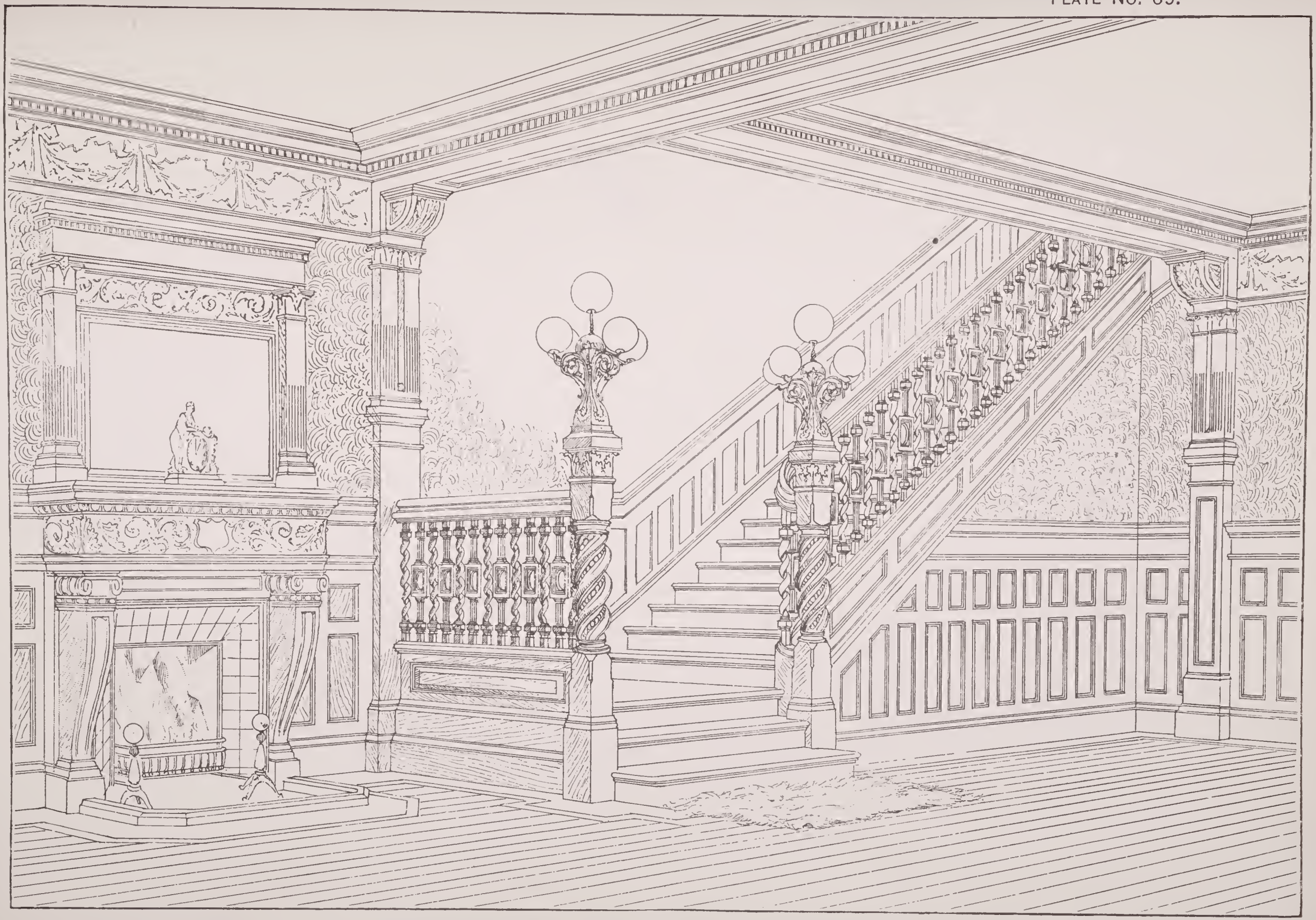
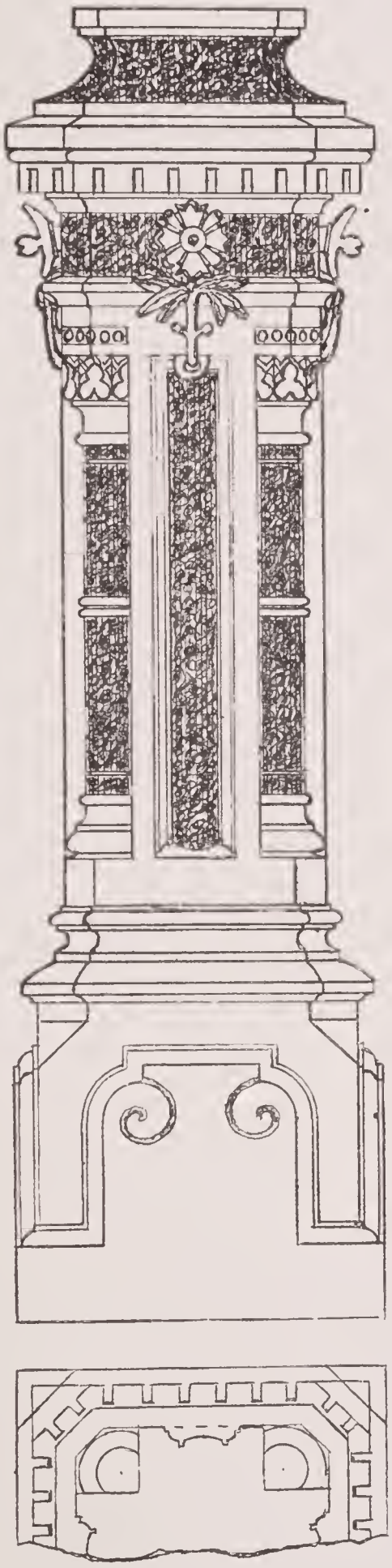
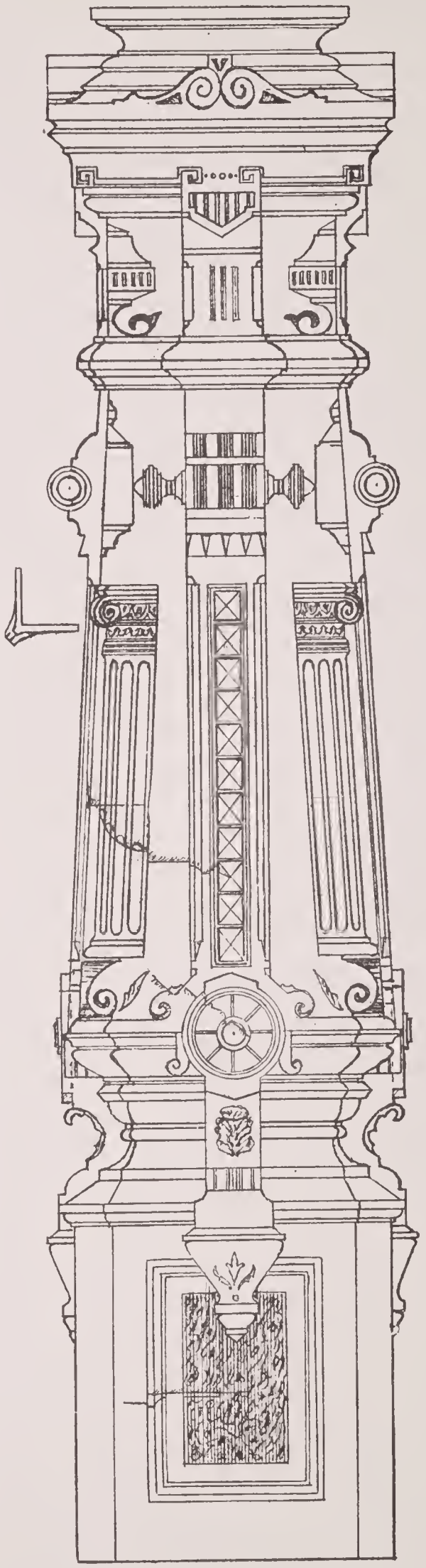


PLATE 70.

Designs for Newels.

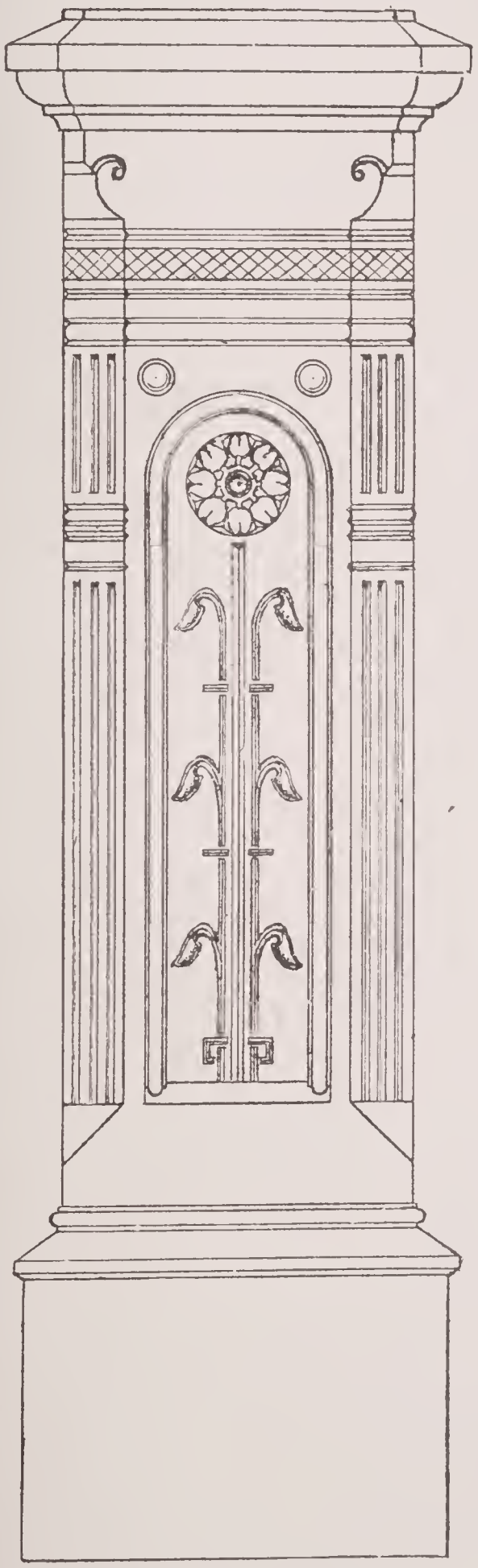


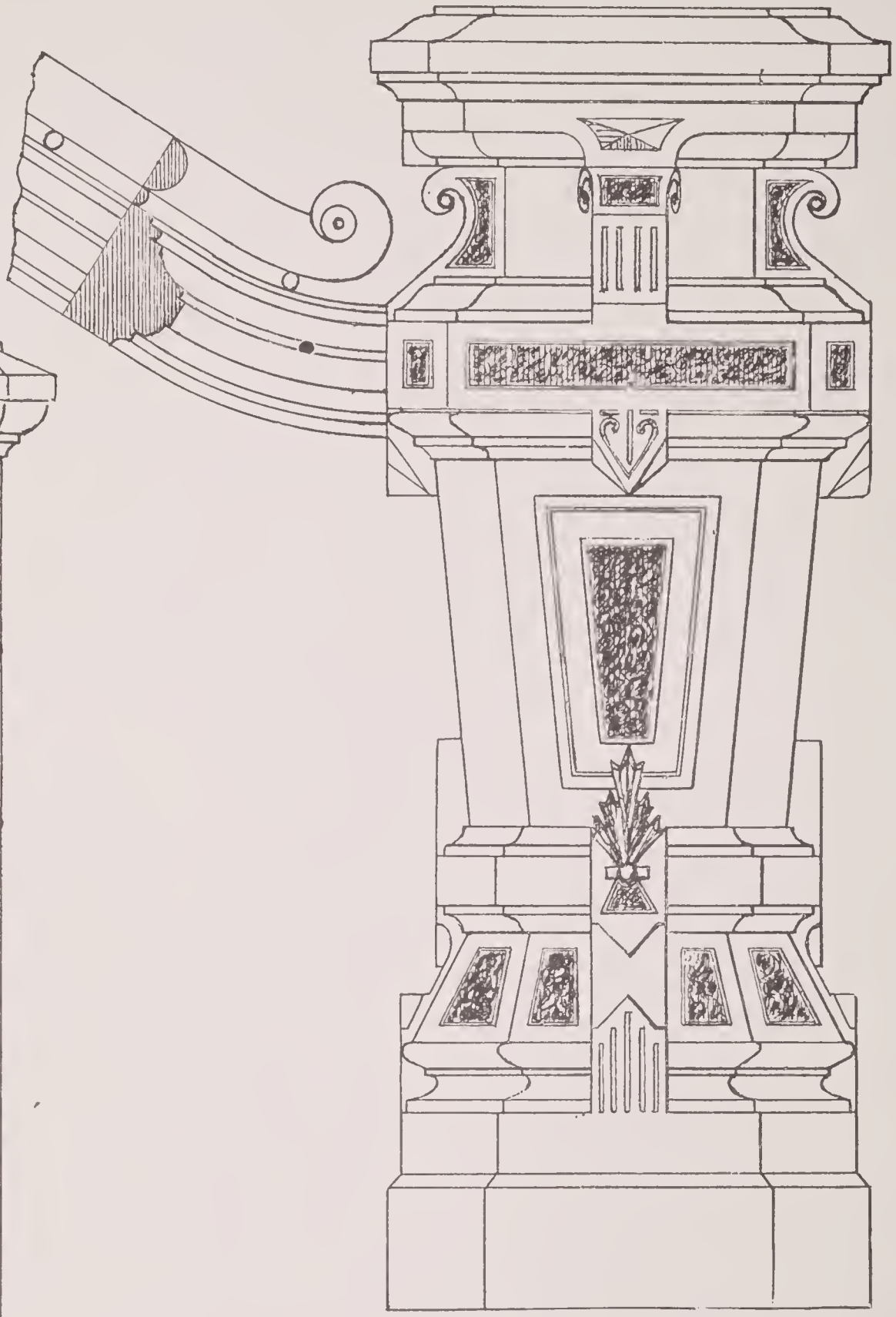


SCALE 1½ IN. = 1 FT.

PLATE 71.

Designs for Newels.

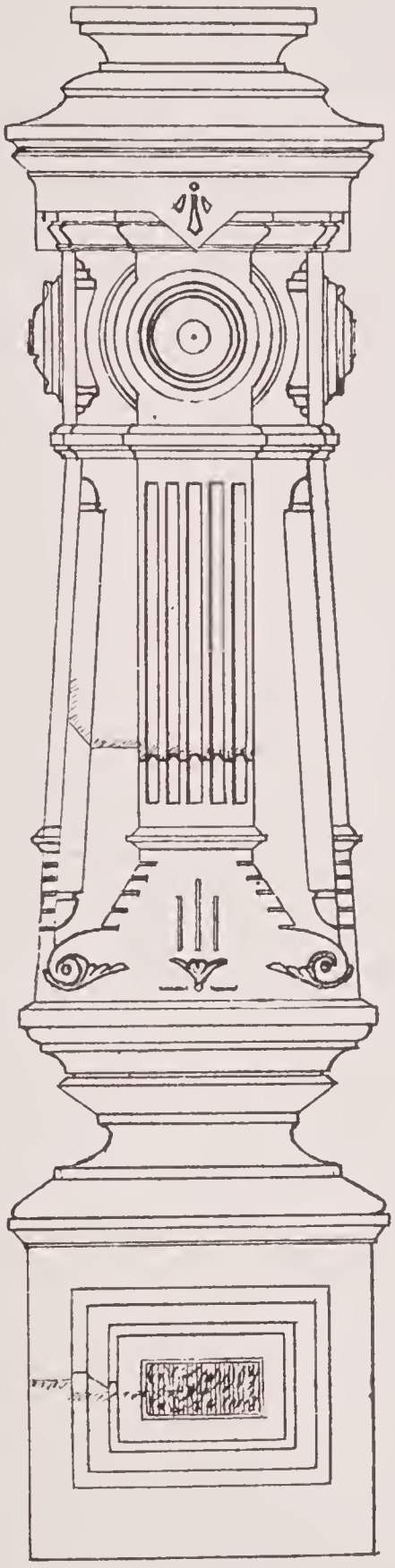


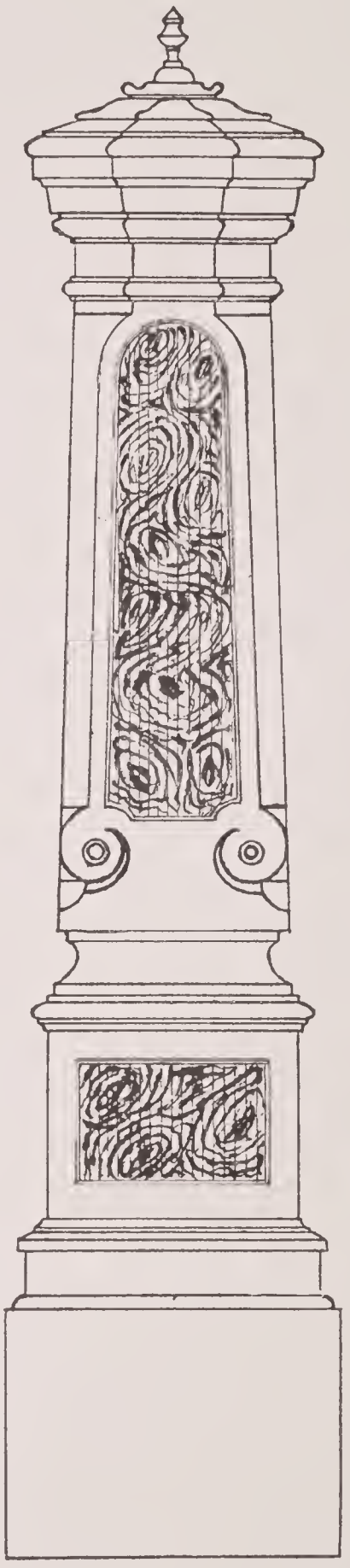


SCALE 1½ IN. = 1 FT.

PLATE 72.

Designs for Newels.

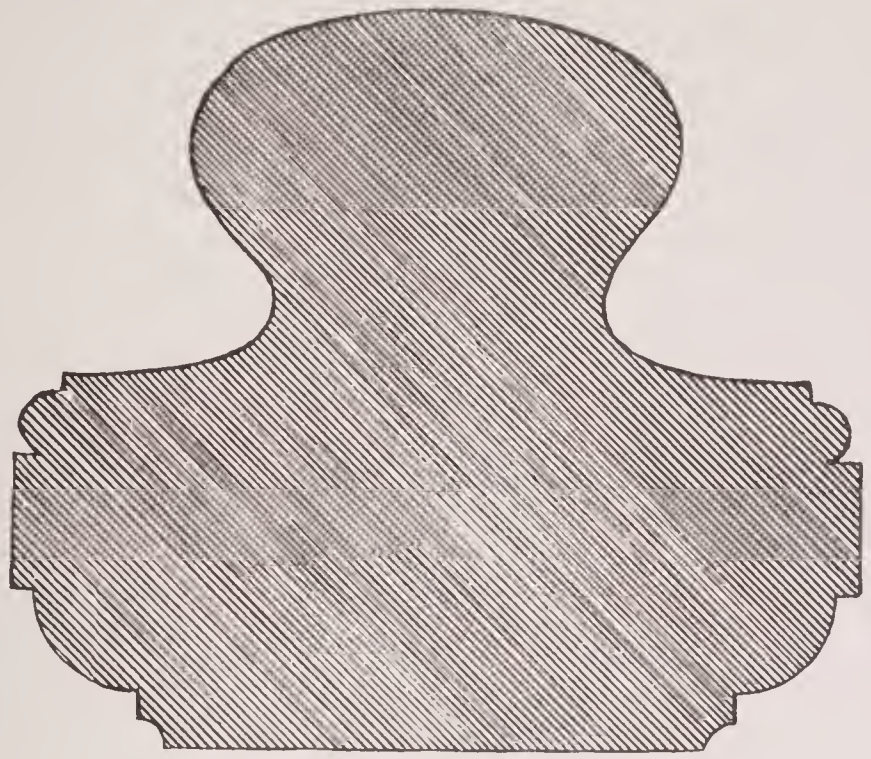


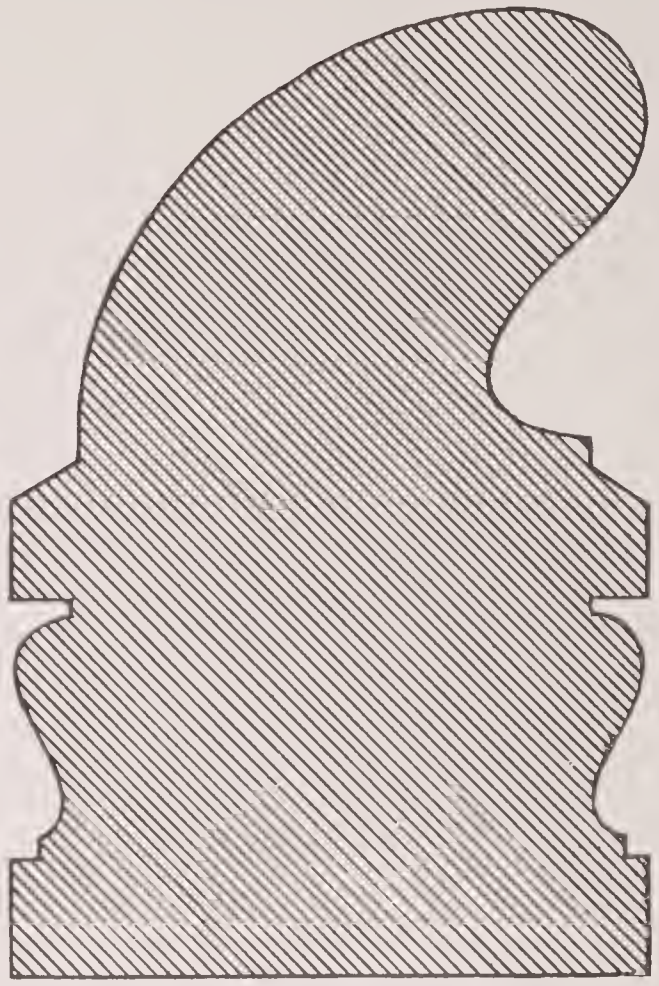


SCALE 1½ IN. = 1 FT.

PLATE 73.

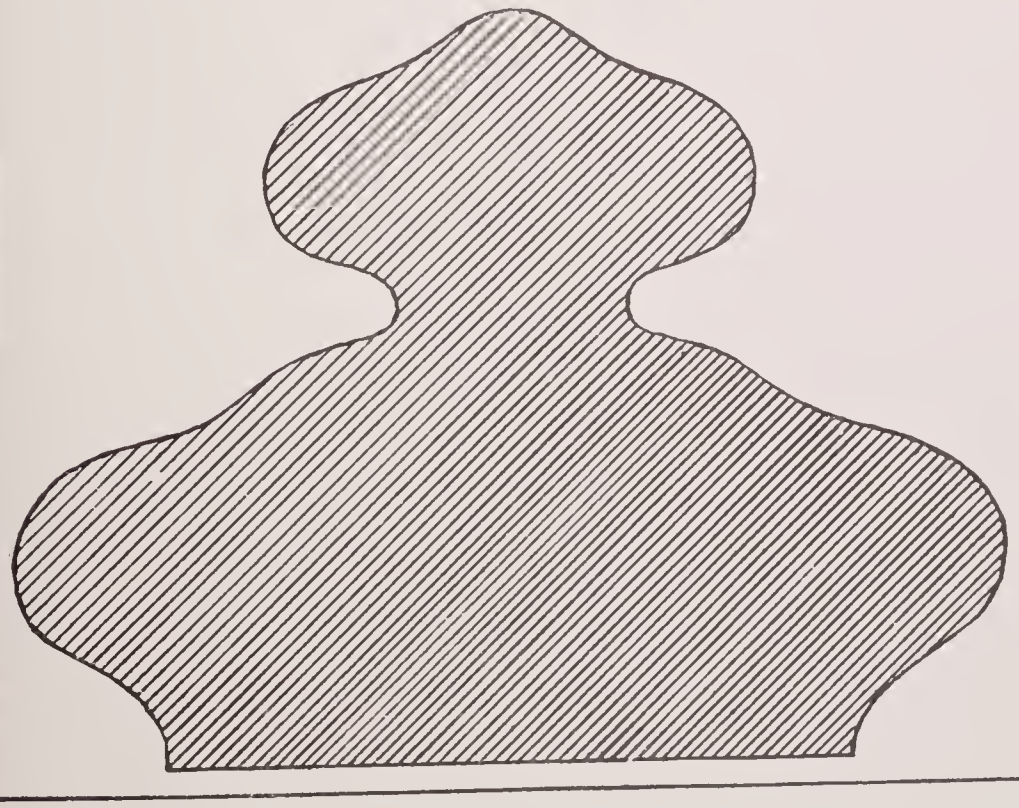
Sections of Hand-rails of Various Forms and Full Size.





SECTIONS OF HAND-RAILS.

FULL SIZE.



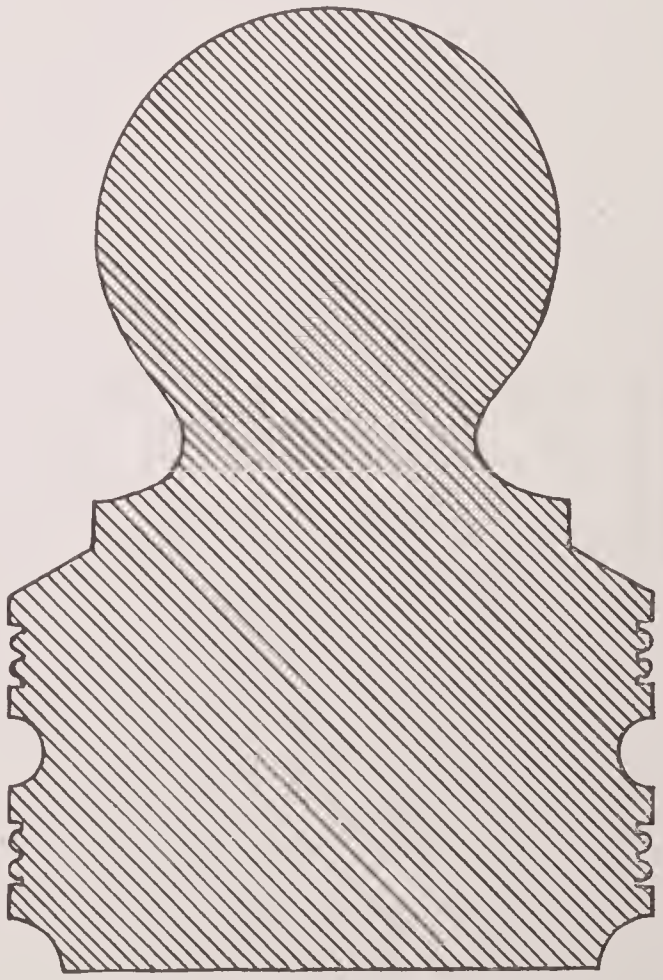


PLATE 74.

Sections of Hand-rails of Various Forms and Full Size.

SECTIONS OF HAND-RAILS.

FULL SIZE.

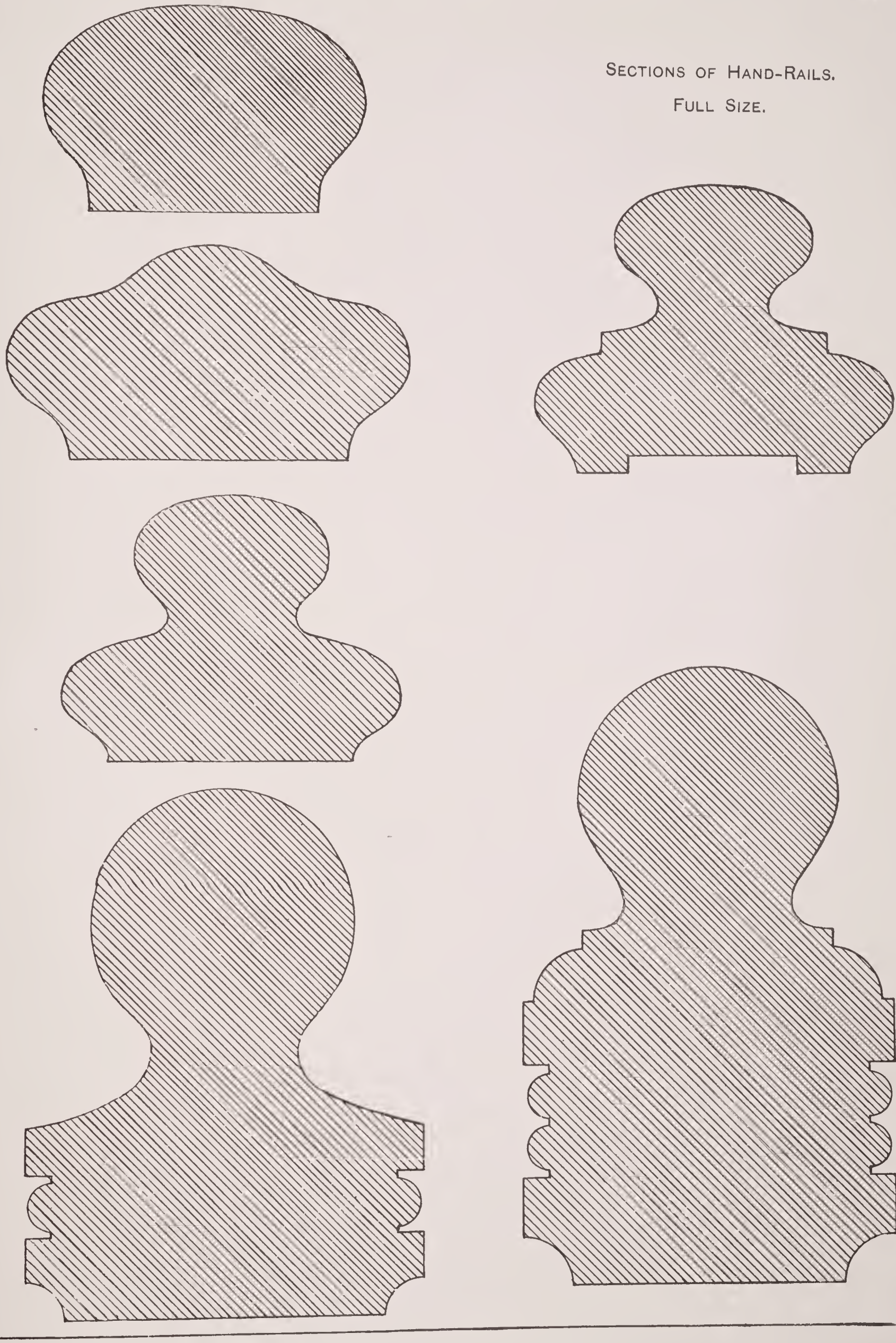
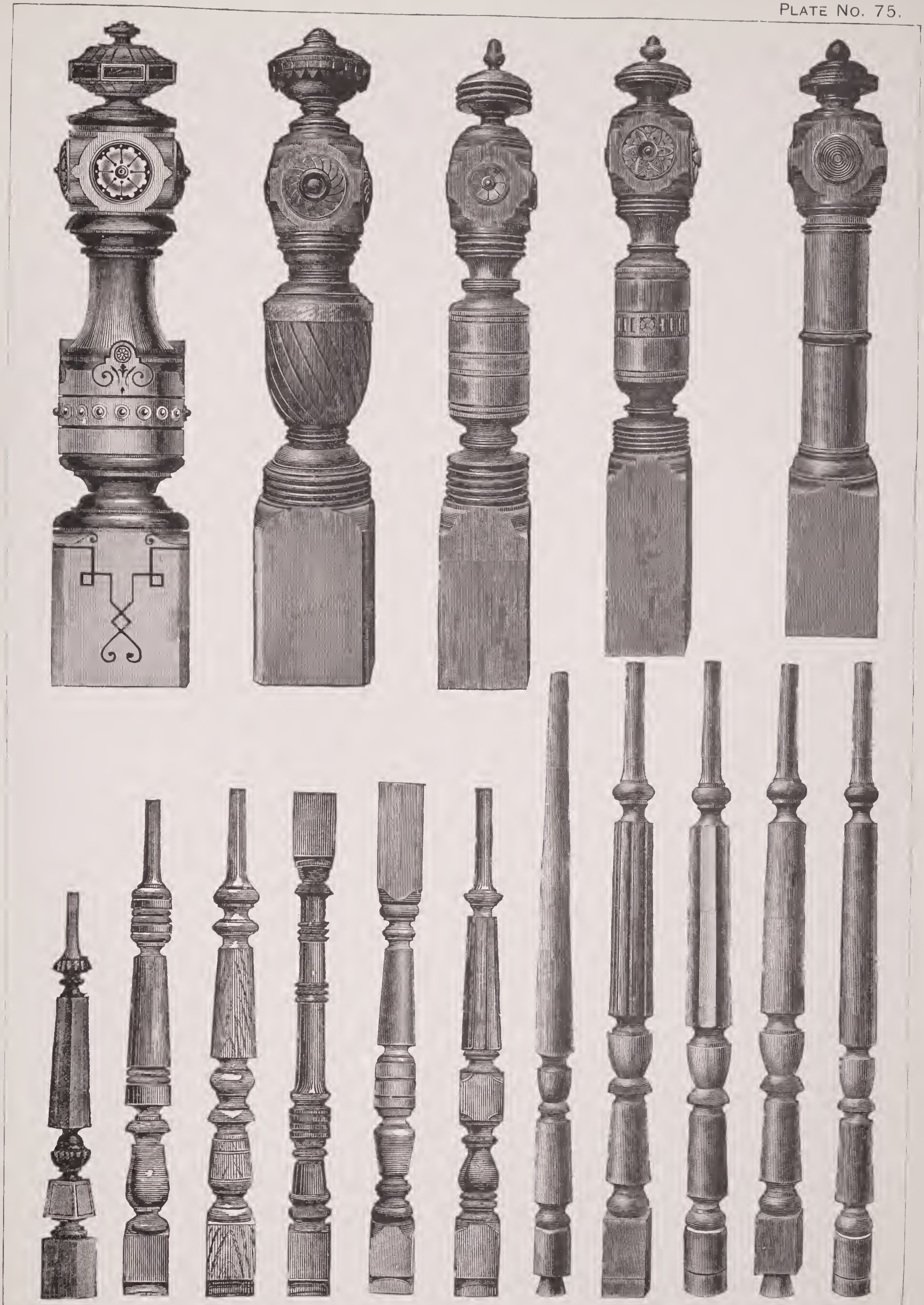


PLATE 75.

Newels and Balusters.



NEWELS AND BALUSTERS OF THESE DESIGNS ARE MANUFACTURED BY THE STANDARD WOOD-TURNING CO., 200 GREENE ST., JERSEY CITY, N.J., U.S.A

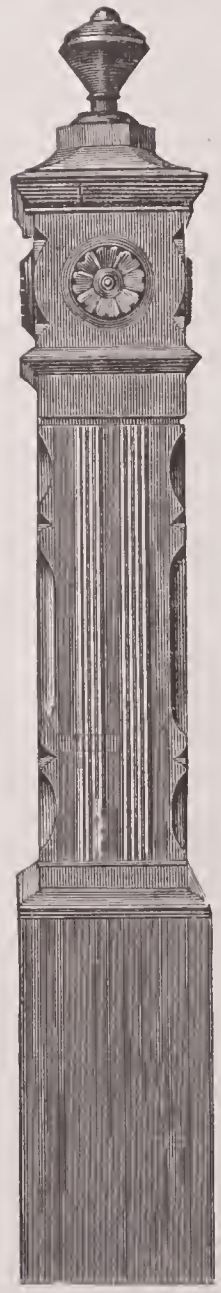
PLATE 76.

Newels and Balusters.

NEWELS AND BALUSTERS OF THESE DESIGNS ARE MANUFACTURED BY THE STANDARD WOOD-TURNING CO., 200 GREENE ST., JERSEY CITY, N.J. U.S.A.

PLATE 77.

Newels and Balusters.



NEWELS AND BALUSTERS OF THESE DESIGNS ARE MANUFACTURED BY THE STANDARD WOOD-TURNING CO., 200 GREENE ST. JERSEY CITY, N.J., U.S.A

PLATE 78.

The Tangentograph.

THE TANGENTOGRAPH. THE FOLLOWING FIGS. REPRESENT THE USE OF THE INSTRUMENT.

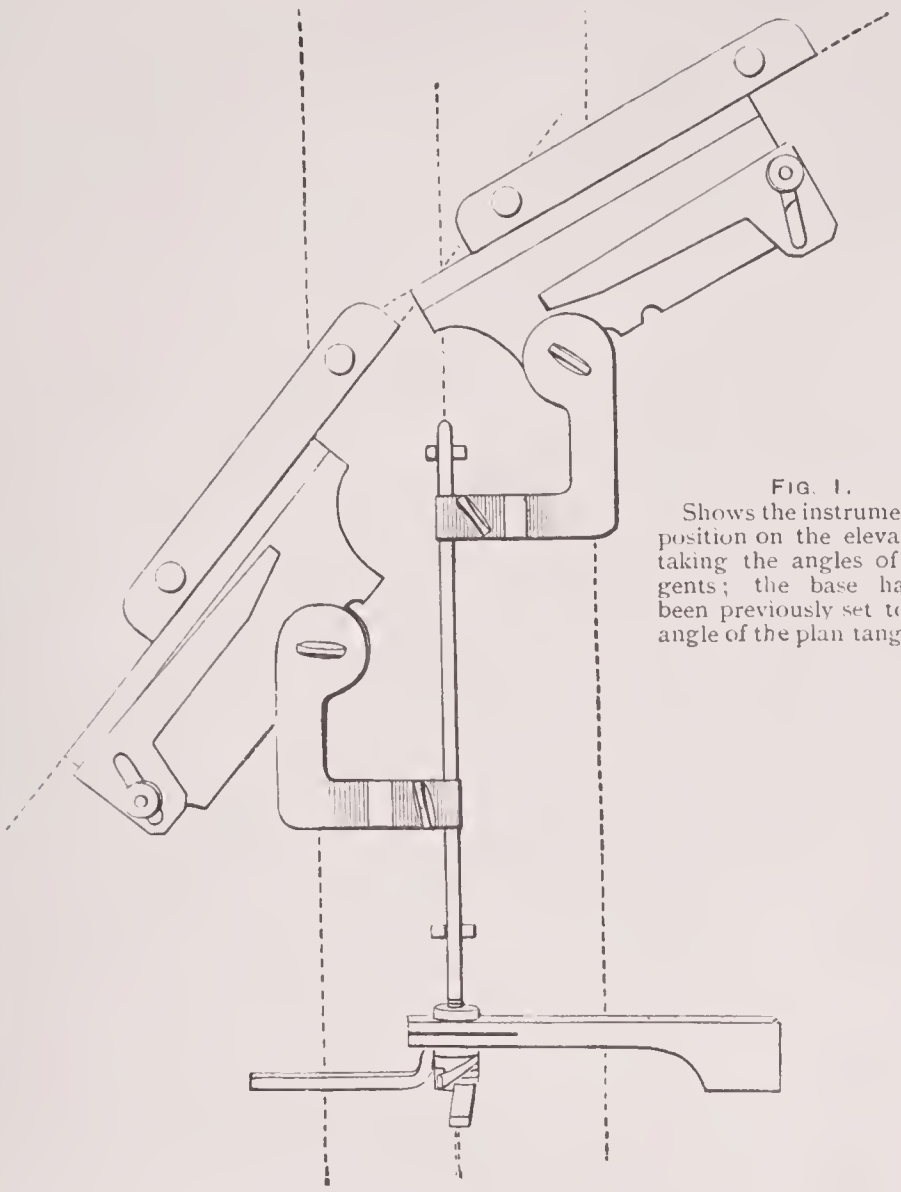


FIG. 1.
Shows the instrument in position on the elevation, taking the angles of tangents; the base having been previously set to the angle of the plan tangents.

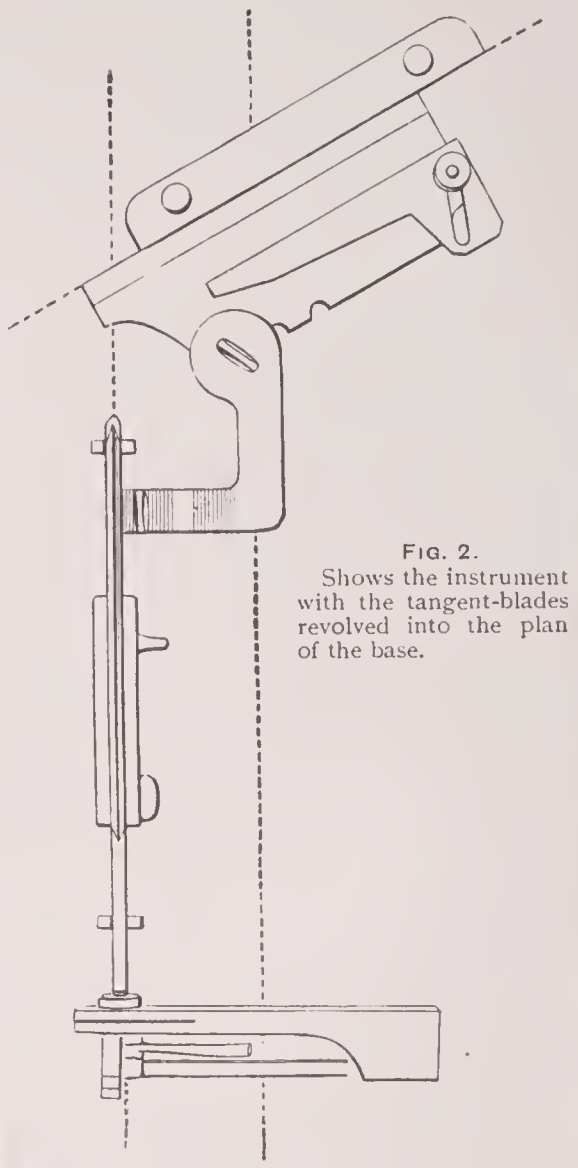


FIG. 2.
Shows the instrument with the tangent-blades revolved into the plan of the base.

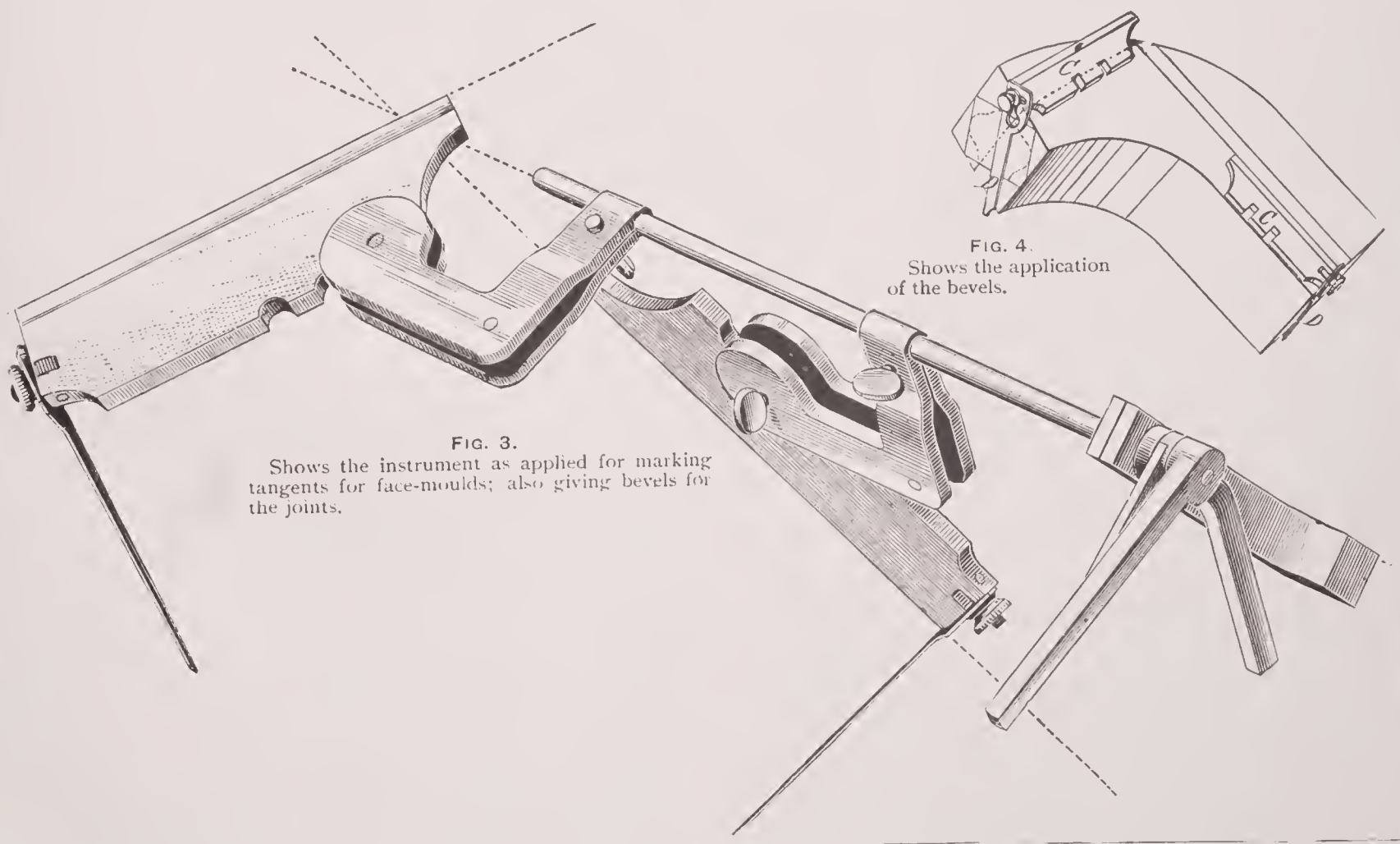


FIG. 3.
Shows the instrument as applied for marking tangents for face-moulds; also giving bevels for the joints.

FIG. 4.
Shows the application of the bevels.

INFORMATION CONCERNING THE ABOVE PATENTED INSTRUMENT MAY BE OBTAINED BY ADDRESSING THE AUTHOR OF THIS WORK, CARE JOHN WILEY & SONS, 15 ASTOR PLACE, NEW YORK CITY.

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